DOCUMENT RESUME

ED 392 593 SE 057 104

TITLE	Facilitating Systemic Change In Science and Mathematics Education: A Toolkit for Professional Developers.
INSTITUTION	Regional Laboratory for Educational Improvement of the Northeast & Islands, Andover, MA.
SPONS AGENCY	Office of Educational Research and Improvement (ED), Washington, DC.
REPORT NO	ISBN-1-878234-08-0
PUB DATE	95
CONTRACT	RP91002001; RP91002002; RP91002003; RP91002004; RP91002005; RP91002006; RP91002007; RP91002008; RP91002009; RP91002010
NOTE	777p.
AVAILABLE FROM	Regional Laboratory for Educational Improvement of the Northeast and Islands, 300 Brickstone Square, Suite 950, Andover, MA 01810.
PUB TYPE	Guides - Non-Classroom Use (055)
EDRS PRICE	MF05 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS	Educational Change; Elementary Secondary Education; *Leadership Training; *Mathematics Education; Mathematics Teachers; *Professional Development; *Science Education; Science Teachers
IDENTIFIERS	Statewide Systemic Initiative

ABSTRACT

This document responds to the need for more people to acquire the necessary knowledge and skills to lead and support changes in how science and mathematics are taught in classrooms, schools, and districts. This document is a set of learning activities that helps those supporting reform efforts to deepen their knowledge about science and mathematics education, dissemination, professional development, and the change process. Further, the activities suggest strategies for engaging all of the necessary people and resources needed for reform to succeed. The activities are grouped under the following headings: setting the stage for reform, effective science and mathematics education, effective dissemination strategies, effective professional development, and effective change strategies. Appendices contain a listing of the Regional Educational Laboratories, techniques for engaging learners, and documentation and evaluation forms. (MKR)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

Facilitating Systemic Change in Science and Mathematics Education: A Toolkit for Professional Developers

ED 392 593

lifelong
learning
for ALL

"PERMISSION TO REPRODUCE THIS MATERIAL
IN **OTHER THAN PAPER COPY** HAS BEEN
GRANTED BY
J. Guyer

TO THE EDUCATIONAL RESOURCES
INFORMATION CENTER (ERIC)"

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION
CENTER (ERIC)

X This document has been reproduced as received from the person or organization originating it.

Minor changes have been made to improve reproduction quality.

- Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

REGIONAL EDUCATIONAL
LABORATORY NETWORK

A Product of the Regional Educational Laboratories

Sponsored by the U.S. Department of Education, Office of Educational Research and Improvement (OERI)

SE057104

BEST COPY AVAILABLE

Facilitating Systemic Change in Science and Mathematics Education:

A Toolkit for Professional Developers

A Product of the
Nation's Regional Educational Laboratories

REGIONAL EDUCATIONAL
LABORATORY NETWORK

Available from
The Regional Laboratory for Educational
Improvement of the Northeast and Islands
300 Brickstone Square, Suite 950
Andover, MA 01810

Sponsored by the U.S. Department of Education
Office of Educational Research and Improvement (OERI)

The Regional Educational Laboratories

Appalachia Educational Laboratory
Charleston, West Virginia

Far West Laboratory for Educational Research and Development
San Francisco, California

Mid-continent Regional Educational Laboratory
Aurora, Colorado

North Central Regional Educational Laboratory
Oak Brook, Illinois

Northwest Regional Educational Laboratory
Portland, Oregon

Pacific Region Educational Laboratory
Honolulu, Hawaii

The Regional Laboratory for Educational Improvement of the Northeast and Islands
Andover, Massachusetts

Research for Better Schools
Philadelphia, Pennsylvania

SouthEastern Regional Vision for Education
Greensboro, North Carolina

Southwest Educational Development Laboratory
Austin, Texas

This publication is sponsored wholly or in part by the U.S. Department of Education, Office of Educational Research and Improvement, under contract numbers RP91002001 through RP91002010. The content of this publication does not necessarily reflect the views of any individual laboratory, the Department of Education or any other agency of the U.S. Government. This publication is available from your Regional Educational Laboratory (see **Appendix A**).

©Copyright 1995, The Regional Laboratory for Educational Improvement of the Northeast and Islands, all rights reserved.

ISBN 1-878234-08-0
Library of Congress No. 95-67282

PREFACE

For nearly 30 years, regional educational laboratories have supported the nation's efforts to improve its schools. As science and mathematics education appeared in the spotlight of the current reform movement, laboratories learned from their clients that they needed a wide range of support to make reform initiatives succeed. *Facilitating Systemic Change in Science and Mathematics Education: A Toolkit for Professional Developers* responds to the need for more people to acquire the necessary knowledge and skills to lead and support changes in how science and mathematics are taught in classrooms, schools, and districts across the country.

Of the hundreds of thousands of people around the country who are concerned about improving science and mathematics education, many are responsible for actually helping teachers and administrators to make improvements. Some are outside of schools: in state education agencies, regional educational laboratories, universities, regional resource centers, and district offices. Others hold leadership positions in schools: principals, members of school leadership teams, department chairs, and teachers with successful practices. While each of these individuals has a wealth of professional expertise, it is rare that any one person is expert in all the areas needed to implement the *systemic* change necessary to ensure that improvements in science and mathematics education endure.

The *Toolkit for Professional Developers* is a set of learning activities that helps those supporting reform efforts to deepen their knowledge about science and mathematics education, dissemination, professional development, and the change process. Further, the activities suggest strategies for engaging all of the necessary people and resources needed for reform to succeed.

This product is just one way the regional educational laboratories seek to support current reforms. Since their inception, the laboratories (funded by the Office of Educational Research and Improvement of the U.S. Department of Education) have proven to be valuable resources in their designated regions. Each laboratory identifies regional needs and develops resources to help meet them. In cooperation with partners in the state and intermediate education agencies, universities, professional associations, foundations, businesses, and social service agencies, the laboratories provide programs and services to schools and others working to improve education.

In 1992, the national network of regional educational laboratories was formally established in recognition of the growing need for coordinated national responses to America's educational challenges and the potential of the laboratories working together to help meet this need. All ten have joined to formalize, consolidate, and extend their capability to act as a national system.

The structure for achieving this goal is a set of collaborative projects, staffed and supported by all or a subset of the laboratories. One laboratory coordinates or leads each project; a project team representing all participating laboratories shapes the project plan and carries out the activities.

The emphases of the projects are science and mathematics education, communications development, system building, and underserved populations. Examples of current projects in addition to the *Toolkit for Professional Developers* are:

- an alternative assessment database,
- a collection of Native American education promising practices,
- teaching cases for professional development,
- a multimedia school improvement resource system,
- urban and early childhood networks, and
- sharing promising and proven practices.

The laboratories have also developed a national telecommunications network, with each serving as a node on the Internet. Databases, communication links, and other services for school improvement are available to every region.

Facilitating Systemic Change in Science and Mathematics Education: A Toolkit for Professional Developers is one product of the Regional Educational Laboratory Network. For more information about the *Toolkit* and/or other products and services, please contact the laboratory that serves your region (see **Appendix A**).

ABOUT THIS BOOK

In the spirit of "truth in packaging," we begin with an explanation of what the *Toolkit for Professional Developers* is and is not. Although its title includes two phrases, "facilitating systemic change" and "science and mathematics education," it is more about the former than the latter. Science and mathematics educators are surrounded by excellent resources, which are ever increasing in number, to help them improve the quality of curriculum, instruction, and assessment in their content areas (see Activities 3 and 4 for several examples). With the exception of 2 of the 19 activities, this product does not attempt to duplicate or improve upon these resources. Instead, we have chosen to focus attention on *change*, albeit as applied to science and mathematics reform. In our experience, we have observed that science and mathematics educators have limited access to resources that help them initiate, plan, manage, and support change. Such resources are often difficult to locate and require time to adapt for use with current reforms. And in many cases the resources simply do not exist; the idea of systemic reform is just emerging as a powerful force and the knowledge and skills needed to effect it are still being formulated. Yet, without consideration of what it takes to help people and systems change, all the resources on science and mathematics will be wasted.

Even with this focus on facilitating change, this *Toolkit* can promise to do little more than create awareness of what is needed to succeed. Skills in "change agentry" take years to develop and we do not pretend that the *Toolkit* will build change agents. Rather, it introduces the key ideas required to understand change in both individuals and systems, creating a common language for designing and supporting reform initiatives. In one sense it "raises the level of discourse" about the challenges ahead, prompting discussions that might never happen otherwise. It suggests additional resources should the user want to learn more.

Finally, the *Toolkit* does not attend equally to all aspects of systemic change. Instead, it emphasizes human resource development: how educators can be supported to develop new understandings and ways to work with young people. Other aspects of systemic change – structures, policies, and power, for example – naturally enter into the discussions, yet they are not the primary responsibility of the professional developer and so are not pursued in any detail in the *Toolkit*. Again, additional references are noted for further study.

We hope this explanation clarifies this product's usefulness and purpose and that you'll find success in these areas with its use.

– Developers of the *Toolkit*

ACKNOWLEDGMENTS

Facilitating Systemic Change in Science and Mathematics Education is the result of true collaboration of staff from the regional educational laboratories (for a listing of the laboratories and their acronyms, see **Appendix A**). Major sections of the *Toolkit* were written by:

Susan Loucks-Horsley (NE&I)
Roxanne Kapitan (NE&I)
Cathy Cook (NCREL)
Glenda Clark (SEDL)
Renee Akbar (SERVE)
Ray Francis (AEL)
Marian Keyes (AEL)
Dave Weaver (NWRL)
Art Sussman (FWL)
Jerome Shaw (FWL)

Other members of the development team, whose assistance in reviewing, enhancing, and piloting was invaluable, included (in alphabetical order):

Winona Chang (PREL)
Sally Crissman (NE&I)
Francena Cummings (SERVE)
Ceri Dean (McREL)
Janice Dilliplane-Kruse (RBS)
Paul Dumas (PREL)
Susan Everson (McREL)
Eileen Ferrance (NE&I)
Carole Fine (NCREL)
Alice Krueger (McREL)
Jackie Palmer (SEDL)
Kit Peixotto (NWRL)
John Sutton (McREL)
Anne Tebo (SERVE)
Abbie Willetto (McREL)

We gratefully acknowledge the expertise, patience, and commitment to making collaboration work of these and our other colleagues at the regional laboratories.

We also appreciate the dozens of educators throughout the country who helped us test each and every activity as part of their own reform initiatives. For their careful reviews and helpful suggestions, we give special thanks to Elliot Seif, Director of Curriculum and Instruction Services, Brooks County Schools Intermediate Unit in Doylestown, Pennsylvania; Brownie Sternberg, Director of Project SMART in Flagstaff, Arizona; and Gary Appel, Codirector of Professional Development for the Michigan State Systemic Initiative.

This enormous product would never have been completed without the persistence and hard work of the editing and production team at the lead laboratory, The Regional Laboratory for Educational Improvement of the Northeast and Islands: Sue Martin, Eileen Stevens, Marie Danella, Clif Lund-Rollins, Priscille Shepard, Marie Underhill, and

Stephanie Wallace. Thanks also to Melissa Chapko (NCREL) for designing the cover.

Susan Loucks-Horsley
Roxanne Kapitan
Team Leaders
The Regional Laboratory for Educational Improvement
of the Northeast and Islands

TABLE OF CONTENTS

PREFACE

ABOUT THIS BOOK

ACKNOWLEDGMENTS

INTRODUCTION I-1

SECTION I: Setting the Stage for Reform

Overview Activity: Orientation to *A Toolkit for Professional Developers* O-1
Activity 1: Framing the Dialogue Around Systemic Change 1-1
Activity 2: Science and Mathematics for All 2-1

SECTION II: Effective Science and Mathematics Education

Activity 3: What Is Effective Science Education? 3-1
Activity 4: What Is Effective Mathematics Education? 4-1

SECTION III: Effective Dissemination Strategies

Activity 5: What Is Effective Dissemination? 5-1
Activity 6: Effective Dissemination Strategies 6-1
Activity 7: Making Good Choices among Successful Practices 7-1

SECTION IV: Effective Professional Development

Activity 8: Understanding Adult Learning 8-1
Activity 9: What Is Good Professional Development? 9-1
Activity 10: Alternative Models of Professional Development 10-1
Activity 11: Planning and Implementing Professional Development 11-1

SECTION V: Effective Change Strategies

Activity 12: Understanding Change in Individuals: The Concerns-Based Adoption Model 12-1
Activity 13: Research-Based Strategies for Districtwide Change 13-1
Activity 14: Organizational Support for Science and Mathematics Education 14-1
Activity 15: Building Collaborative Teams 15-1

Activity 16: Systems Thinking: A New Mental Model 16-1
Activity 17: A Continuum of Systemic Change 17-1
Activity 18: Expanding Our Understanding of Systemic Change 18-1

APPENDICES

Appendix A: Regional Educational Laboratories A-1-1
Appendix B: Techniques for Engaging Learners B-1-1
Appendix C: Documentation and Evaluation Forms C-1-1

INTRODUCTION

The current wave of reform in science and mathematics education promises to contribute to our country's productivity and well being. Yet, it is not without its challenges, as these examples illustrate:

* * *

Across the country, NSF-supported State Systemic Initiatives in states, cities, and rural areas have created a demand for science and mathematics specialists to help schools transform their science and mathematics programs. This is a great opportunity to take advantage of the talents of the nation's very best teachers! But many of them do not know how to design professional development opportunities, to help leadership teams think about how to change their schools, or to help teachers choose among the wide variety of effective programs and practices that are available for their use. They need new strategies and skills if they are to be successful in their new roles.

* * *

Each year, the national network of Eisenhower Mathematics and Science Regional Consortia search for promising science and mathematics programs and practices and publish a catalog describing them. As a result, educators from all around the country who want to learn more about these programs are calling the schools in the catalog for more information. How can the teachers and administrators in these schools be prepared to respond? What materials, presentations, and formats for hosting visitors will best represent their programs, while allowing them to tend to the ongoing task of teaching their students?

* * *

Science and mathematics are the focus of two of the National Education Goals: that American students will leave grades 4, 8, and 12 having demonstrated competency in challenging subject matter, including science and mathematics, and that U.S. students will be first in the world in science and mathematics achievement. The amount of activity in science and mathematics indicates that people are serious about improvement, if not real transformation. But many of these people – among them school and district administrators, general curriculum coordinators, teachers, parents, and community and business leaders – have no particular expertise in science and mathematics, nor are they well connected to what has been happening nationally in these areas. They need information and *understanding – and ways of connecting new approaches in science and mathematics education to their own work.*

* * *

In each of these examples, people are being asked to stretch their current skills and knowledge, develop new strategies for working with their colleagues, and become a part of the newest movement toward more effective science and mathematics education. Although many of these people are professional developers themselves, all of them have professional development needs. This product was developed for them.

The purpose of the *Toolkit for Professional Developers* is to broaden and strengthen the expertise of individuals currently helping teachers and schools improve science and mathematics teaching and learning. The areas of general concern designate the sections:

- Setting the Stage for Reform
- Effective Science and Mathematics Education
- Effective Dissemination Strategies
- Effective Professional Development
- Effective Change Strategies

Two critical, interrelated themes weave throughout the sections: (1) using a *systemic* approach to change that (2) ensures *equitable* access and achievement of science and mathematics for *all* students. The first theme, systemic reform, stems from the realization that a new kind of thinking is needed if the current reform is to succeed where past ones have failed. Such thinking considers all parts of the system rather than one at a time; pays as much attention to the ways the parts are linked as to the parts themselves; and focuses on efforts to redesign the system based on a clear, shared vision of what it takes for all learners to succeed. Educators need practice in thinking beyond their own responsibilities, understanding that each change in the system results in other changes, and considering ways to integrate their efforts more with those of others.

The second theme weaving through the sections is equity. Systemic change efforts cannot occur until we take a careful look at inequities that have occurred in the past and develop commitment and strategies to avoid repeating these inequities in the future. "Learning for all" needs to take on real meaning for people. It must include a commitment to eliminate achievement differences and underrepresentation of most minority groups and females in science- and mathematics-related professions. The themes of systemic change and equity begin the activities in the *Toolkit* and are revisited throughout.

A Toolkit for Professional Developers is designed as a series of activities that can be used with a variety of audiences. Like an actual toolkit, it contains tools for many different situations: some of these situations are illustrated in the examples described above. The user of the *Toolkit*, called the "facilitator," needs to choose activities based upon the perceived needs, roles, and expertise of the intended audience. Because of the importance of the themes of systemic change and equity, all work should begin with **Activity 1: Framing the Dialogue Around Systemic Change**, and **Activity 2: Science and Mathematics for All**. **Figure 1** on page I-4 provides some examples of how additional activities from the *Toolkit* might be used with specific audiences.

The activities in the *Toolkit* are meant to be learning experiences. They are formatted as group sessions but can also be used as individual study guides (although learning with others has its advantages over self-study). Some activities require the facilitator to have more specialized expertise than others. Some draw on a solid knowledge base about what works; others are meant to stimulate the thinking of participants around a dilemma or areas of thinking that are just emerging. All require the facilitator to be sensitive to the needs of adult learners, to be able to set up situations where learning is dynamic and multifaceted, and to appreciate the time and effort it takes to develop new understandings and skills.

We tried to design the activities from a "constructivist" perspective, i.e., to help each participant engage actively with new ideas and applications and make them his or her own. As appropriate, we used a learning sequence familiar to science and mathematics educators, proceeding generally from initial engagement to exploration, explanation, and application. Facilitators will want to add their own strategies to encourage learning. For example, in our pilots, we sometimes asked participants to keep journals, writing what they knew about a topic before the activity began and then reflecting back after completing the activity.

Many activities call for specific techniques to engage people in learning; these techniques are included with instructions and transparency masters in **Appendix B**.

Figure 1:
Tailoring *Toolkit* Use for Different Audiences

For science and mathematics teachers assuming change agent roles:

- Orientation: Section I
- Main Tool: Section V (Effective Change Strategies)
- Order will depend on the specific role teachers are assuming. For example,
  - Staff of state, urban, rural, and local systemic initiatives: Activities 16-18, 15, 14, 12, 13
  - Members of district or state frameworks, restructuring, professional development committees: Activities 15, 16-18, 13, 12, 14
  - School or district staff: Activities 13, 12, 14, 15, 16-18
- Optional Tools: Section IV if change is primarily through professional development, or Section III if change is largely through selection and implementation of new programs and practices

For developers of successful science and mathematics programs or practices:

- Orientation: Section I
- Main Tool: Section III (Effective Dissemination Strategies)
- Order might be Activities 5, 6, 7
- Optional Tools: Section IV (especially Activities 8, 9, and 11) to design professional development for a new program or practice

For teachers assuming roles of professional developers, mentors, trainers, etc.:

- Orientation: Section I
- Main Tool: Section IV (Effective Professional Development)
- Order: Sequential
- Optional Tools: Section V (Activity 12) and Section II (Activities 3 and 4)

For policymakers and administrators:

- Orientation: Section I
- Main Tool: Section II (Effective Science and Mathematics Education)
- Order: Any
- Optional Tools: Section V (Activities 13, 14, and 16-18)

Each activity contains the following information:

- audience,
- desired outcomes for participants,
- materials,
- time required,
- facilitator's notes,
- process, and
- additional references.

There are masters for transparencies, handouts, and readings when called for by the activity; the "additional references" are recommended for facilitators and/or participants who would like a more in-depth study of the topic.

Appendix C contains two documentation and evaluation forms. Since we view the *Toolkit* as a growing document, we would appreciate knowing how it is being used and with what success and problems. Please join the network of *Toolkit* users by completing the forms each time you use an activity. This will be one important source of input for ongoing improvement and enhancement.

There are endless learning activities and materials that could have been included in this *Toolkit*, and so we encourage you to look beyond what is here and be creative. The knowledge, skills, and issues that are the focus of the *Toolkit* activities are only a start to building the repertoire needed for those helping schools.

SECTION I:
SETTING THE STAGE FOR REFORM

Overview Activity:	Orientation to *A Toolkit for Professional Developers*	O-1
Activity 1:	Framing the Dialogue Around Systemic Change	1-1
Activity 2:	Science and Mathematics for All	2-1

Section I: Setting the Stage for Reform

The purpose of Section I is to provide an overview of the *Toolkit* and address the two important strands that run throughout the book: systemic change and equity. The activities are:

- **Overview Activity: Orientation to *A Toolkit for Professional Developers*.** This activity introduces participants to the *Toolkit*, providing an opportunity for them to assess their own learning needs and interests and identifying the learning opportunities that the *Toolkit* makes available to them.

- **Activity 1: Framing the Dialogue Around Systemic Change.** This activity introduces the concept of a system and systems thinking, using a film clip to provide a metaphor for an effectively working system. Participants develop their own working definition of systemic reform, which they elaborate on through other *Toolkit* experiences.

- **Activity 2: Science and Mathematics for All.** This activity explores the inequities of current science and mathematics education, building an understanding of the nature of the problem and multiple strategies for addressing it.

Section I has been used extensively to introduce groups engaged in reform of science and mathematics to both the idea of systemic reform and the *Toolkit* as a vehicle for learning. Some examples are:

- Teams from dozens of school districts come together each summer at the Smithsonian Institution in Washington, DC, for the National Science Resources Center's week-long Elementary Science Leadership Institute. There the teams work on plans to reform their elementary school science programs. Early in the week, parts of Section I are used to introduce them to the ideas of systemic change, provide them with a common language, and begin their discussions of what components of their system need to change and how.

- At a regional educational laboratory conference on science and mathematics reform, 60 people representing a variety of institutions, projects, and organizations from four states came together for the first time to share and learn from each others' efforts. Parts of Section I were used to stimulate discussion about areas of common interest and begin to build a shared understanding of the nature of systemic change.

O

OVERVIEW ACTIVITY: ORIENTATION TO A TOOLKIT FOR PROFESSIONAL DEVELOPERS

Audience:

- Individuals responsible for reform in science and mathematics education.
- Individuals who will be participating in several *Toolkit* activities.
- Individuals interested in learning about the *Toolkit*.
- Individuals who want to know more about the *Toolkit* to determine whether they or others would benefit from further use.

Desired Outcomes for Participants:

- To become familiar with the basic purpose, format, and rationale of the *Toolkit*.
- To become part of a learning community engaged in using the *Toolkit* as a resource.
- To connect current priorities to topics addressed in the *Toolkit*.

Materials:

- **Transparencies:**
  - *The Toolkit Overview* (O-6)
  - *Three-Step Interview* (B-6-2)
  - *Home Team: Three-Step Interview Questions* (O-7)
  - *Prioritize These Concerns* (O-8)
  - *Reform Mingle* (O-9)
  - *Fast-Write Reaction* (O-10)
  - *Think-Pair-Share* (B-7-3)
  - *Purposes of the Toolkit* (O-11)
  - *Activity Format* (O-12)
  - *Scavenger Hunt* (O-13)
  - *Assumptions Underlying the Toolkit* (O-14)
  - *Three Hats* (O-15)
- **Handout:**
  - *Prioritize These Concerns* (O-16)

- Overhead projector, screen, blank transparency, and overhead pens
- A copy of *Facilitating Systemic Change in Science and Mathematics Education: A Toolkit for Professional Developers* for each participant
- Colored adhesive dots, nametags, blank paper, and pens or pencils

Time Required: One hour

Facilitator's Notes: The Overview Activity is meant to introduce people to the *Toolkit*. It is especially helpful for participants engaging with the *Toolkit* for extended periods of time, such as for one or more days or for a series of sessions throughout the school year. Before conducting this activity, make sure to read the full introduction to the *Toolkit*, since it sets the stage for the what, how, and why of this resource. Whereas many of the other *Toolkit* activities represent a body of knowledge, the scope of this Overview Activity will vary a lot. We encourage you to pick and choose among the process steps to tailor an overview session that makes sense for your objectives and audience.

The process steps described here are framed as the first session of a series of *Toolkit* activities. With a bit of adjustment, it can be made into a stand-alone overview.

Process:

1. Show **The *Toolkit* Overview (O-6)** transparency to set the stage for the purposes of the activity.
2. If *Toolkit* activities will be used over several consecutive days, assemble participants into heterogeneous "Home Teams" of four that will meet for 15 to 30 minutes at the beginning and end of each day. (Use colored dots on name tags to coordinate easy identification of team members.) The advantages of home teams are many – they:
    - serve as mini-learning communities;
    - provide a social and professional anchor; and
    - are a place to check-in continuously during the sessions.
3. Review the Three-Step Interview technique (see **Appendix B-6** and use the **Three-Step Interview [B-6-2]** transparency to explain). Show the **Home Team: Three-Step Interview Questions (O-7)**

transparency for the three interview questions and have participants interview each other.

4. Distribute the handout **Prioritize These Concerns (O-16)** and use the **Prioritize These Concerns (O-8)** transparency to explain that collectively, over time, we have probably all done reform work in these four areas. Have participants individually look over the list and prioritize which of the four is the number one concern in their work right now, which has second priority, and so forth, putting the appropriate number next to each item.

5. Show the **Reform Mingle (O-9)** transparency and have the group carry out tasks 2, 3, and 4. Allow 10 to 15 minutes.

6. Ask for a show of hands for the four priority areas to see how many chose each as their number one choice. Say that over the years they have probably each made a number of assumptions about their first choice. Explain the Fast-Write technique (see **Appendix B-7** and **Fast-Write Reaction [O-10]** transparency) and tell them that they will now have a chance to write about some of their assumptions. Then tell them the following story:

   This is a story about two donkeys. They were on a long journey together. One of them was carrying a load of salt, the other a load of cotton. As they traveled they complained to each other. The donkey with the salt cried, "Oh, my aching back – this load is so heavy!" The donkey with the cotton moaned, "This cotton is so bulky – it's getting in the way of everything!" And so they journeyed – each one complaining to the other until they drove each other crazy.

   Eventually they came to a river. The donkey with the salt said to himself, "I know how I can lighten my load," and waded into the river. The soothing water washed over him and when he was satisfied he came out of the river and dried himself in the sun.

   *The other donkey, watching his friend happy with a lighter load decided to wade in the river also. He went gaily into the water and after a time was ready to dry off. To his surprise he could barely move. Instead of a lightened load it was breaking his back. As he struggled to climb the river bank and stand next to his contented friend, he realized that his assumptions about the river and what it could do for him had changed.**

---

*This story is adapted with permission of Robert Garmston, Facilitation Associates, El Dorado Hills, CA.

7. Show the **Fast-Write Reaction (O-10)** transparency and give participants two minutes to write. Have them share the essence of what they wrote with a partner. After about five minutes, share a few of your own assumptions that have changed.

8. Ask how many thought five or ten years ago that they would be engaged in the kind of systemic science and mathematics reform work they are currently doing. Ask how many are playing a stronger "change agent" role than ever before.

   To continue the mix and mingle rhythm of this overview activity, have participants pair up with someone they have not yet worked with for three rounds of Think-Pair-Share questions (see **Appendix B-7** and use the **Think-Pair-Share [B-7-3]** transparency), talking to different partners for each question:

   - Describe the role (or your role) as a change agent.
   - What challenges do change agents face?
   - What would you like to learn about the change agent role?

9. Ask participants to turn to the table of contents in their *Toolkits*. Point out that when they prioritized their areas of concern they were essentially looking at the major sections of the *Toolkit*. Review the sections and clusters of activities under each one. To help the group understand that the *Toolkit's* content extends beyond the subjects of science and mathematics, you may want to draw a circle on a blank transparency. Then, drawing a wedge onto the circle, explain that science and mathematics as distinct areas of exploration represent about 15 to 20 percent of the knowledge base in the *Toolkit*. Explain that the other four sections – systemic change, dissemination, professional development, and equity make up the rest of the topics in the resource. Have them turn and share why these other areas were included. After a few minutes, point out that systemic reform entails a lot more than a content- or program-based focus. They will have a chance to explore all five areas.

   Point to **Figure 1** on page I-4 of the Introduction to the *Toolkit*, saying that the activities can be used in a wide variety of ways.

   Explain that the *Toolkit* was developed collaboratively by all ten regional educational laboratories and is designed to round out the expertise of individuals in leadership roles with regard to science and mathematics reforms. Note where the *Toolkit* treats some of the needs they said they had as change agents.

10. Walk the group through the **Purposes of the *Toolkit* (O-11)** and **Activity Format (O-12)** transparencies, having them flip through a sample activity during the second transparency.

11. Show the **Scavenger Hunt (O-13)** transparency. In groups of three or four have participants do the items on it. The items can be found as follows:

    - Startling Statements – the first part of Activity 2
    - Think-Pair-Share – Appendix B-7
    - last phase is "implementation" – Activity 5 (5-10, 5-14, and 5-15)
    - Critical Attributes – Activity 9 (9-28 through 9-40)
    - Stages of Concern – Activity 12 (12-13)

12. In summary, review the **Assumptions Underlying the *Toolkit* (O-14)** transparency. You may also want to mention that the people present at the training might be wearing any combination of the following that are shown on the **Three Hats (O-15)** transparency:

    - *participant*: absorbed in the moment's learning;
    - *user*: wondering how they are going to use the information in their own work; and
    - *facilitator*: calculating how they would "teach" the information and methods in the *Toolkit* to others.

    Allow each person to talk about the primary "hat" they are wearing within small groups. Finally, ask if there are any questions about the *Toolkit*.

Additional Reference:

Fullan, Michael. March 1993. "Why Teachers Must Become Change Agents." *Educational Leadership* 50 (6): 12-17.

THE TOOLKIT OVERVIEW IS DESIGNED TO

- Introduce a NEW RESOURCE: Facilitating Systemic Change in Science and Mathematics Education: A Toolkit for Professional Developers

- Demonstrate Toolkit CONTENT and PROCESS

- Encourage sharing of ISSUES of high concern

HOME TEAM: THREE-STEP INTERVIEW QUESTIONS

- What do you know so far about the Toolkit?

- Compare your position to a kitchen gadget (what and why).

- What is your current professional challenge?

PRIORITIZE THESE CONCERNS

- What is effective science and mathematics education?
- How can we best disseminate and help educators select among good programs and practices?
- What is effective professional development and what are models that can make it happen?
- How can we foster systemic change?

REFORM MINGLE

1. Prioritize your reform concerns.
2. Move about pair up with someone and compare priorities.
3. Keep switching partners until you find a close or exact match.
4. Sit down and compare efforts around your priority areas: Why did you prioritize them in that way?

FAST-WRITE REACTION

How have your ASSUMPTIONS about your #1 priority area of concern CHANGED over the last few years?

PURPOSES OF THE TOOLKIT

- To help LEADERS of science and mathematics reform develop knowledge and skills
- To give leaders TOOLS activities, readings, planning guidelines, resources they can use in their work
- To model STRATEGIES that help adults learn
- To narrow the gap between RESEARCH and PRACTICE

ACTIVITY FORMAT

- Audience
- Desired outcomes for participants
- Materials
- Time required
- Facilitator's notes
- Process steps
- Additional references
- Transparencies
- Handouts
- Readings

SCAVENGER HUNT

- Name one Startling Statement.
- What and where is Think-Pair-Share?
- What is the last phase of the "Dissemination Continuum?"
- What are three critical attributes of professional development?
- What is your "Stage of Concern" with respect to the Toolkit?

ASSUMPTIONS UNDERLYING THE TOOLKIT

- Learning requires active participation.
- Everyone has a wealth of expertise.
- No one knows it all.
- It's important to build a community of learners.
- Questions are as important as answers.
- There is no need to reinvent the wheel.

THREE HATS

Participant

↓

User

↓

Facilitator

PRIORITIZE THESE CONCERNS

- What is effective science and mathematics education?

- How can we best disseminate and help educators select among good programs and practices?

- What is effective professional development and what are models that can make it happen?

- How can we foster systemic change?

1

FRAMING THE DIALOGUE AROUND SYSTEMIC CHANGE

Audience:

- Individuals responsible for reform in science and mathematics education.

Desired Outcomes for Participants:

- To understand the nature of systems thinking.
- To develop a rationale for why change in science and mathematics education needs to be systemic.
- To devise a working definition of systemic reform.

Materials:

- **Transparencies:**
  - *Understanding Systems* (1-8)
  - *Reflection* (1-9)
  - *Dialogue* (1-10)
  - *Characteristics of Systemic Reform* (1-11)
  - *Systems Thinking* (1-12)
  - *The Toolkit as a System* (1-13)
  - *Three Hats* (O-15)
  - *Three Hats Looking Back* (1-14)
- **Handouts:**
  - *Characteristics of Systemic Reform* (1-15)
  - *Continuum of Buy-in Strategies* (1-16)
- **Reading:**
  - "Leading Through Systems Thinking" from *Leadership for Tomorrow's Schools*, by Jerry L. Patterson. Alexandria, VA: Association for Supervision and Curriculum Development, 1993, 66-79.
- Overhead projector, screen, blank transparencies, and overhead pens
- Videotape of the movie "Witness," Paramount Pictures, 1985
- VCR and monitor
- Newsprint, easels, markers, tape, and pens or pencils

Time Required: Three hours

Facilitator's Notes: The *Toolkit for Professional Developers* is useful only within a context of new thinking about change in education. Many of the individual activities have been used for years to develop knowledge and skills related to particular aspects of a professional developer's role. What is new today, however, is the idea of systemic thinking – the imperative that what we do in one aspect of education be integrally related to what we do in all others, and that the sum of those actions be centered on a shared vision of learning and how to reach all learners.

The challenge for the facilitator is to help participants develop specific new skills and knowledge, and yet keep those related to the big picture of systemic change. In every activity of the *Toolkit*, we have suggested ways to help participants do so. In addition, we have developed this activity to provide a frame of reference – a beginning understanding of systems thinking in the context of systemic reform – that can be used as additional *Toolkit* activities unfold.

An anticipated outcome of this activity is that participants will have their own "working" definition of what a systemic reform effort looks like. If they have had no other exposure to the ideas of systemic change and systems thinking, their new understandings will be quite thin. You may choose to deepen that understanding at this early juncture by using activities towards the end of the *Toolkit* (Activities 16 through 18).

The alternative, which is suggested by how we have actually sequenced the activities in the book, is to have participants develop new knowledge and skills in some of the areas most relevant to their work – related to effective science and mathematics education, dissemination, and/or professional development – and have them reconsider their working definition of systemic reform as they learn. In this way, they will "construct" their knowledge of systemic change over time through learning and applying new ways to be effective in their work. After they have done so, it may be more powerful to turn to the last set of activities in the *Toolkit* to deepen and broaden their knowledge.

Process:

1. Before the activity, fast-forward the video "Witness" to the barn-raising scene, about two-thirds of the way through the film.

2. Explain that this activity is intended to help participants develop a framework for systemic change – for feeding their vision of how

current reform efforts need to be different from reforms of the past so that they can be more successful.

3. Have participants work in groups of three, giving each a sheet of newsprint and different colored markers. Ask them to first brainstorm various systems they know about (e.g., the circulatory system, the telephone system, the library system) and to choose one system to depict on the newsprint. Have the groups display their newsprint and describe what makes it a system.

4. Show the **Understanding Systems (1-8)** transparency and walk through the definition (citing the Patterson book), giving examples of things that are and are not systems. Ask the groups to compare their system to this formal definition to see if there is a match.

5. Tell the group that you are going to show them a scene from the movie "Witness" to illustrate a working system. Show the **Reflection (1-9)** transparency so they know what to look for. Introduce the story from the movie:

   While waiting for a train with his widowed mother, a young Amish boy witnesses the murder of an undercover narcotics agent. When the boy identifies a high ranking member of the police force as the murderer, the police detective (Harrison Ford) reports this only to the police commissioner. Though seriously injured in an attempt on his life, Ford manages to get the boy and his mother back to their Pennsylvania Amish community. Because of the potential danger to the community if he is discovered, Ford is nursed back to health and grudgingly allowed to participate in the life of the Amish community as one of their own. The clip you are going to see depicts Ford's participation in a barn raising. The movie takes place in the mid 1980s.

   Show the barn-raising scene. After the music ends and the lunch prayer begins – about ten minutes – turn the movie off.

6. After the film clip, have the groups discuss the questions in the **Dialogue (1-10)** transparency. After about ten minutes, direct a whole group discussion about the three questions. Summarize by saying that in a healthy working system all the parts must work in unison toward an established purpose. Have them bring to mind the barn-raising scene again and ask the group to imagine what would happen if any of the following were true:

   - there was no agreement about the units of measurement;

- there was no opportunity for the children to lea[illegible];
- meat was served when the community was vegetarian;
- half the "lifters" decided not to lift; and
- the whole community decided barns were useless.

Solicit any additional comments from the group.

7. Using their knowledge about how healthy systems work, ask the small groups to think about an innovation of the past, preferably in science or mathematics. They may select the New Math, the inquiry approach to science embodied in such programs as SCIS and ESS, or more general ones such as the open classroom. Have them discuss why these innovations did not succeed in widespread change in schools and classrooms.

8. Ask for some of the reasons they thought of and write them on newsprint or a blank transparency. Note that some of the reasons relate to structures that were absent (e.g., no staff development), or were not aligned (e.g., same old tests), or to knowledge, beliefs, or attitudes that did not support or worked against the change.

9. Ask participants to imagine a situation where such reforms were able to succeed (they may draw on their own experiences or observations of successful change). Give each group another piece of newsprint. Ask them to depict, in whatever way they want, such a situation. What elements would they expect to see, to connect, to enact, in order for such reforms to be successful? Allow 20 minutes.

10. Have participants post their newsprint and give them the assignment to scan the others and see if they missed something. Allow them to return to their depictions and add, delete, change them in any way they find useful.

11. Distribute the handout **Characteristics of Systemic Reform (1-15)** and display the **Characteristics of Systemic Reform (1-11)** transparency. Explain that this is a beginning definition. Encourage participants to use this definition as a starting point (or not) – scribble on it, change, add, etc. to begin to form a definition that represents their depiction of the key elements of reform. Ask participants to work in their groups and spend 20 minutes coming up with their own version of a working definition. Consensus is not required; each individual may want his or her definition to vary

from those of others. Have them write their own definition on a clean piece of paper for reference at later times.

OR

In order to arrive at one definition, conduct a Pyramidal Process for Developing Consensus (see **Appendix B-5**). Have each individual write their own definition first, referring to or revising the one on the handout **Characteristics of Systemic Reform (1-15)**. Allow ten minutes.

Then have them work in pairs to come up with one definition (ten minutes). Have pairs combine into fours to do the same (ten minutes), and so on through eights, sixteens, etc. (each new grouping for ten minutes) until the group is whole and one definition is the result.

Stress that the result is a *working* definition. As they have new opportunities to learn they may and probably will want to change it. Review the working definitions.

12. Tell participants that one of the most important aspects of any systemic effort is the notion of shared vision. (Probably each of their definitions will have included something about shared vision.) Point out that all of the people in the barn-raising scene believed in what they were doing – they had buy-in. Explain that buy-in doesn't just happen – it needs to be developed over time. Mandates often fail when they provide no opportunities for people to develop ownership.

13. Distribute the handout **A Continuum of Buy-in Strategies (1-16)** and have each group brainstorm one role group in science and mathematics reform efforts. One end of the continuum has the "zany" strategies, while the "practical" ones go at the other end (give them an example). Assign each group one of the following role groups, asking them to write their target group on the handout (or make up your own):

    - mathematics teachers
    - science teachers
    - principal
    - district curriculum director

- assessment committee at the state department
- superintendent
- parents
- middle school students

14. Distribute the reading, "Leading Through Systems Thinking." Tell the groups that using systems thinking requires doing things differently. Assign each group one or more of the seven guidelines beginning on page 68 of the reading. Ask groups to read the description of their guideline(s) and discuss its implications for their buy-in strategies – would they do things the same or differently, based on the guideline?

    Have each group report out key insights about the systems thinking guideline(s) and the top two buy-in strategies for their role groups. Point out that using these "systemic" guidelines will increase the probability that new reforms will take root. Rather than the incremental and fragmented approaches of the past, today's initiatives really hold the promise of becoming "the way we do things around here."

15. End by showing the **Systems Thinking (1-12)** transparency and have participants reflect on the meaning of the quote in pairs or through journal writing.

16. *(Optional)* If participants have or are working on school or district action plans, ask them to relate the seven guidelines to their plans. What might they do differently?

17. *(Optional)* As the first activity in this resource you may want to explain how the *Toolkit* itself is a system using **The *Toolkit* as a System (1-13)** transparency. This will be especially important if you plan on doing a number of *Toolkit* activities with the same group of people.

18. *(Optional)* Show the **Three Hats (O-15)** transparency from the overview activity and ask participants to get together with others (about three or four) who wore the same hat during this activity. Ask each group to dialogue about the questions from the **Three Hats Looking Back (1-14)** transparency.

Additional References:

Dyer, William G. 1984. *Strategies for Managing Change.* Reading, MA: Addison-Wellesley.

______________ 1994. *Team Building: Current Issues and New Alternatives.* Reading, MA: Addison-Wellesley.

Fullan, Michael. March 1993. "Why Teachers Must Become Change Agents." *Educational Leadership* 50 (6): 12-17.

Maeroff, Gene I. March 1993. "Building Teams to Rebuild Schools." *Phi Delta Kappan* 74 (7): 512-517.

Patterson, Jerry L. 1993. *Leadership for Tomorrow's Schools.* Alexandria, VA: Association for Supervision and Curriculum Development.

Senge, Peter. 1990. *The Fifth Discipline: The Art and Practice of the Learning Organization.* New York: Doubleday Currency.

Wilson, Meena. March 1993. "The Search for Teacher Leaders." *Educational Leadership* 50 (6): 24-27.

UNDERSTANDING SYSTEMS

A system is a collection of
parts that interact to
function purposefully
as a whole.

A collection of auto parts is NOT a system

A working car IS a system

REFLECTION

During "WITNESS," think about how the barn-raising scene reflects a working system.

DIALOGUE

- In what ways did the barn-raising scene reflect a working system?
- What were the "parts"?
- In what ways did the parts interact to function purposefully as a whole?

CHARACTERISTICS OF SYSTEMIC REFORM

- Centers on a vision of all students as successful learners of ambitious learning outcomes
- Integrates curriculum, teaching, assessment, and school organization towards the shared vision
- Attends to professional development, curriculum development, and organizational development
- Has structures and mechanisms for cross-role collaboration
- Incorporates ongoing inquiry and reflection

Source: Reprinted with permission of Education Commission of the States from "Introduction to Systemic Education Reform." ©1992.

SYSTEMS THINKING

Seeing "WHOLES," recognizing PATTERNS and RELATIONSHIPS, and learning how to structure those relationships in more EFFECTIVE, EFFICIENT ways.

— Senge 1990

Source: Senge, Peter. 1990. *The Fifth Discipline: The Art and Practice of the Learning Organization*. New York: Doubleday Currency.

THE TOOLKIT AS A SYSTEM

- Provides ways for transforming academic research into meaningful practice

- Contains tools that professional developers can use to further reform efforts

- Addresses science and mathematics initiatives as a system by examining major areas of reform

THREE HATS
LOOKING BACK

Participant:	What key learnings, surprises, or insights did you have during this activity?
User:	How might you use the knowledge base or process steps from this activity in your own work?
Facilitator:	How will you help others to use the knowledge base from this activity? Which facilitation techniques were new or inspiring for you? How can you use these techniques with other content in your own work?

CHARACTERISTICS OF SYSTEMIC REFORM

- Centers on a vision of all students as successful learners of ambitious learning outcomes.

- Integrates curriculum, teaching, assessment, and school organization towards the shared vision.

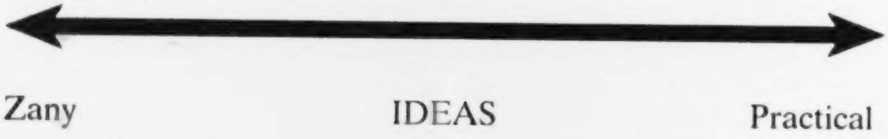
- Attends to professional development, curriculum development, and organizational development.

- Has structures and mechanisms for cross-role collaboration.

- Incorporates ongoing inquiry and reflection.

Source: Reprinted with permission of Education Commission of the States from "Introduction to Systemic Education Reform." ©1992.

CONTINUUM OF BUY-IN STRATEGIES


Zany
IDEAS
Practical

Reprinted with permission of the author from Leadership for Tomorrow's Schools by Jerry L. Patterson. (c) 1993, 66-79.

6

LEADING THROUGH SYSTEMS THINKING

When things go wrong in today's organization, leaders go hunting for people to blame. They have been indoctrinated in the belief that people are the causes of problems and that problems are solved by swiftly correcting the behavior of the "problem" employees. If problems persist, leaders generally believe that their only recourse is to fire the "problem" employees.

In tomorrow's organization, problems will be viewed much differently. Throughout this book, the emphasis has been on opening the organization to participation, diversity, conflict, reflection, and mistakes. When it comes to problems, tomorrow's leaders will open the organization in another way: They will open the organizational *system* itself to examination as a possible cause of problems. In short, leaders will shift away from blaming problems on individuals and move toward ferreting out the problems that are inherent to the system at work in the organization.

Although the concept of systems thinking has been around for decades, the language and tools of systems thinking have been by and large obscured in complex and intricate formulas and diagrams. In this chapter, we will look at a framework that will enable tomorrow's leaders to take the basic principles of systems thinking and apply them to real-life organizational problems. We will review guidelines for better understanding systems thinking and then apply the guidelines to a case study involving a school district's struggle with a systems problem.

BEST COPY AVAIL

UNDERSTANDING SYSTEMS

The first step in understanding systems is to work from a common definition of the term: A system is a collection of parts that interact to function purposefully as a whole. The best way to draw meaning from this string of words is to contrast examples of what is and is not a system. For instance, a collection of parts in the back room of an auto repair shop is not a system. Nor is a structure assembled from those random parts; it may be a piece of art or a piece of junk, but it is not a system. By assembling particular parts so they work together to produce power for operating a lawn mower, however, we create a system.

A system must include parts that interact in a purposeful manner, and this interaction must produce a whole that is greater than the sum of its parts. The lawn mower engine is more than the individual parts lying in the back room; it is a functional system that becomes a nonfunctioning heap of parts if any significant piece is missing.

Applying this definition of a system to organizations, we find that anytime we bring together people and materials to achieve an organizational purpose, we create a system. Most systems exist within larger systems. A teacher, a classroom, some instructional materials, and twenty-five children constitute a system. Fifteen of these systems within a building form a larger system called a school. And eighteen of these schools make up a school system. The school system, in turn, is part of a larger, more complex system serving the needs of the families living in the community. We can even work our way into systems as complex as a universe. For now, though, we will focus on the concept of systems designed to educate our children.

GUIDELINES FOR APPLYING SYSTEMS THINKING

If we really want to resolve problems in our organization, we must move systems thinking from academic discourse to meaningful practice. The following guidelines will help you apply systems thinking in your own organization:

- Focus on the system, not the people.
- Learn how the current system evolved and how it connects to related systems.
- Expect the system to resist interventions meant to disrupt the stability of the current system.

BLE

- Evaluate the system against the organization's core values.
- Look beyond symptomatic problems and symptomatic solutions to fundamental systems issues.
- Think whole-system, long-term solutions and allow time for the solutions to take effect.
- Anticipate new systems problems arising from current systems solutions.

In the remainder of this section, we'll look at how each of these guidelines can be successfully applied toward organizational improvement.

GUIDELINE 1: FOCUS ON THE SYSTEM, NOT THE PEOPLE.

Most workers are well-intentioned people who are simply trying to perform as best they can what they understand their duties in the organization to be. Teachers, for instance, usually are trying to conform to ideas about teaching and learning that were taught to them in education courses and that were developed and reinforced in their work with students in schools. As criticisms mount regarding the quality of education provided in our nation's schools, the typical response in today's organization is to search for people who aren't pulling their weight—even though they may be doing exactly what they were taught to do—and then "fix" them or fire them.

In tomorrow's organization, the response to perceived problems will shift. For instance, if we think the quality of schooling is not meeting changing expectations about what constitutes student success, we need to identify our new expectations, then redesign our systems to provide teachers the training and support to meet the new expectations. Instead of blaming individuals for doing what they were hired to do, we need to make long-term adjustments by focusing on system changes.

Let's look at another problem scenario. Imagine that a school district is losing talented administrator candidates to surrounding school districts. The superintendent blames the staff of the human resources department for not pursuing candidates aggressively enough and warns them that if they continue to let qualified people slip through their fingers, heads are going to roll.

Tomorrow's leaders will see this problem quite differently. They will move the organization away from blaming the staff of the human resources department and move toward an examination of the entire system involved in recruiting, interviewing, and selecting administrators. By changing the system to become more aggressive in advertising positions, by shortening the time line from posting positions to hiring, and by offering more competitive salaries, the issue will be addressed systemically and the people involved in the hiring process will not become the scapegoat for the organization's problem.

GUIDELINE 2: LEARN HOW THE CURRENT SYSTEM EVOLVED AND HOW IT CONNECTS TO RELATED SYSTEMS.

Some leaders rush to tackle pressing problems without considering how the system in which the problem exists was put together in the first place. For instance, imagine a school board member being elected on a platform of saving taxpayers money. The board member volunteers to serve on the teacher negotiations committee in hopes of presenting compelling, rational evidence for why the teachers should settle for a modest salary increase. To the board member's surprise and disappointment, final decisions regarding teacher salaries have little to do with an individual board member's powers of persuasion and everything to do with how comparable districts have settled their negotiations. In addition, if the teachers union and the school board reach an impasse, a third-party mediation system goes into effect to settle the dispute.

This board member could have more effectively channeled her energy by learning the history of teacher negotiations in the district and the role of the mediation system. With such background information, she would have been well-situated to negotiate from a position of strength rather than naïveté.

In tomorrow's organization, leaders will find that time spent learning the history of the system and its connection to related systems is an investment in quality systems solutions for the future.

GUIDELINE 3: EXPECT THE SYSTEM TO RESIST INTERVENTIONS MEANT TO DISRUPT THE STABILITY OF THE CURRENT SYSTEM.

Stability is one of the hallmarks of a working system. Every system incorporates defense mechanisms that protect it from the constant bombardment of stimuli trying to disrupt its stability. In most cases, the harder the pressure against the system, the harder the system pushes back to resist change. When today's leaders meet resistance to change, they think, "Okay, if you want to play hardball, I'll show you how hardball is really played!" Instead of trying to understand why they are meeting resistance, they prepare themselves to aggressively do battle with the system to see who will prevail. With this mindset, it's usually the entrenched ways of the system that win.

For example, suppose a new high school principal is hired with a mandate from the school board to put in place interdisciplinary team teaching. The principal brings in highly touted speakers on the subject of integrated learning. He regularly attends high school departmental meetings to try to convince teachers of the merits of this new way of teaching. He also eliminates the position of the high school department chair, replacing it with grade-level chairpersons. Within six months, the principal reports to his supervisor that the staff has organized against him and is doing everything possible to sabotage his efforts to bring about change. In short, the system is resisting outside threats to its stability.

Suppose, however, the principal introduced the idea of interdisciplinary team teaching by acknowledging that the teachers were opposed to it and then inviting teachers to tell him exactly why they were opposed to it. He appeals to the teachers union and school board for waivers to the teachers' contract, which discourages teachers from taking such risks as accepting new, experimental class assignments. The principal also provides the incentive of additional release time for groups of people willing to initiate interdisciplinary team teaching. In other words, the principal works *within* the system to remove barriers and increase incentives. Although the process of making individual adjustments to the system is slow and arduous, it is generally more successful than fighting against the entire system all at once.

GUIDELINE 4: EVALUATE THE SYSTEM ACCORDING TO THE ORGANIZATION'S CORE VALUES.

Too many of today's organizations are driven by events. Leaders hop from one quick fix to another, skipping the important step of determining what business the organization is in and what it stands for. Consequently, when problems occur, the leaders have no enduring values to guide their problem-solving efforts. Because they have not identified the common purpose toward which all the organizational systems should be working, they try to solve problems by arbitrarily tinkering with the parts. When their blind tinkering causes even bigger problems, they inevitably resort to blaming the people who have been following their lead all along.

Let's look at a concrete example of an event-driven organization. Suppose Anderson Elementary School is having trouble with parent acceptance of the elementary report card. A vocal group of parents wants the school to give letter grades so parents will have a more realistic view of their children's performance. In fact, some parents want actual percentages, such as

94 percent, assigned to each subject area on the report card. Accordingly, the school changes the report card.

Three years later, parents want effort grades assigned to each subject. The school again changes the report card. Two years after that, the district redraws school attendance boundaries due to major population shifts. The parent population of Anderson School changes markedly, and this new group of parents wants to return to a more narrative report card. What will the school do now?

Let's shift gears and imagine that Anderson Elementary School is now using systems thinking in making decisions. The staff recognizes that there is disagreement about how report cards should describe student progress. They also realize, however, that report cards are only part of a system centered on the idea of student success. Consequently, they decide to examine their fundamental beliefs about student success, including discussions about how to measure it and how to communicate standards for success to students and parents. They involve parents in this examination of beliefs and reach consensus on a core organizational value concerning student success. Then they describe how the system—including report cards—should work to reinforce this core value.

The development of a core value concerning student success puts this staff in a much better position to examine system problems that may arise in the future. Any fundamental changes can now be considered in the light of this core value. Necessary changes should be well received, since the staff members (and the parents) have already agreed on the value and examined the system accordingly.

GUIDELINE 5: LOOK BEYOND THE SYMPTOMATIC PROBLEMS AND SYMPTOMATIC SOLUTIONS TO FUNDAMENTAL SYSTEMS ISSUES.

Too often we latch onto an apparent problem within a system and attempt a quick fix. In complex systems, especially, the competition for scarce time, energy, and other resources pushes us to quickly identify a problem, solve it, and move on. For example, suppose teachers start complaining that the district is being left behind while other school districts are moving to site-based management. The teachers union begins sending memos to the superintendent and the school board inquiring when the district is going to involve teachers in decision making. Even parents get into the act and ask about their involvement in future decisions. Letters appear on the editorial page of the local newspaper, and teachers union officials speak up at school board meetings.

Feeling the pressure, school board members ask the superintendent what the district is doing about site-based management. Taking the hint, the superintendent sends ten staff members to a workshop sponsored by the state department of education. In addition, a team from another school district speaks to the superintendent's advisory council about the merits of forming school improvement teams and developing school governance councils.

Addressing the issue of site-based management, the superintendent directs all schools to develop school improvement teams within three years. Also, he says that the governance of each school will be handled through a school council comprising teachers, parents, and the principal. Each person gets one vote on school issues brought to the council. With these mechanisms in place, the superintendent is satisfied that the system issues have been addressed and resolved. When relationships among teachers, parents, and administrators deteriorate further, the superintendent starts blaming people for not following through on the directed organizational changes.

Where did things go wrong here? For starters, the superintendent paid attention to the symptomatic problem: not having site-based governance in place. If the superintendent had followed Guideline 4 (concerning core values), he would have discovered that the fundamental issue was teachers' and parents' desire to be viewed as people with worthwhile contributions to make to the decision-making process. The superintendent made another mistake by proposing a symptomatic solution. He recast organizational structures without first confronting the issue: What are this district's fundamental beliefs about the participation of stakeholders in the decision-making process?

In tomorrow's organization, the superintendent will work toward a solution that reflected these fundamental beliefs, creating forums for constituents from various perspectives to discuss how their needs for participation can best be met within the organization's core values. After the needs have been identified, the superintendent will provide direction in making sure that the organizational practices are consistent with the core values.

GUIDELINE 6: THINK WHOLE-SYSTEM, LONG-TERM SOLUTIONS AND REMAIN PATIENT FOR THE SOLUTION TO TAKE EFFECT.

As discussed previously, a system can be found in a space as small as a classroom or as large as a universe. The temptation in today's organization is to focus on the system most apparently in need of attention. To illustrate, let's examine some apparent scheduling problems associated with adopting the middle school model of schooling.

The junior high scheduling model is fairly straightforward. Every teacher teaches six periods a day, five days a week. Teachers who do not have enough sections to warrant a full-time contract may pick up an additional section at the high school level. Under the middle school arrangement, scheduling is more complicated. Teachers are expected to team-teach in blocks of time up to four hours in length. This model does not neatly accommodate teachers in need of an additional section to complete a full-time contract. It also requires rethinking how certain subjects, such as music and foreign languages, can fit into block scheduling instead of the traditional period scheduling.

With all of these possible headaches, the approach today's leaders usually take is to give up on the new system and stick with what works. Tomorrow's leaders will adopt a different strategy. First they will ask, "What are we trying to accomplish philosophically with the middle school model?" Once the organization has clarified these values, it will look at all the systems affected. Scheduling is only one consideration. Other systems include integrating subject areas, incorporating the student advisor concept, and providing common team planning time. As leaders help the organization identify solutions, they will need to keep in mind that the middle school concept can't be implemented overnight. They are looking at a minimum commitment of three years of the district's resources to implement the new system.

Finally, such a commitment will require patience to see the solution through to completion. In the short run, the fundamental solution won't be very gratifying because it creates immediate headaches without assurance of long-term success. If leaders can stay focused on the whole-system, long-term solution, they can resist the temptation to slide back into dwelling on short-term problems like scheduling that only produce symptomatic solutions. Instead, leaders will focus on what they're trying to accomplish for students, and approach the barriers within this context.

GUIDELINE 7: ANTICIPATE NEW SYSTEMS PROBLEMS ARISING FROM CURRENT SYSTEMS SOLUTIONS.

We often spend so much time and energy getting our fundamental solutions in place that we have little tolerance for any problems incurred from implementing the solution. We have gone to great lengths to convince others that a given solution is the most effective one for our particular system. We have offered assurances that the overall system will benefit from significant long-term results. Then we get blindsided by new problems.

More specifically, our advocacy blinds us to the inherent drawbacks of our solution.

Returning to the middle school dilemma discussed above, imagine that we finally get school board and school staff support to move ahead with this new system. Two years later, as we put the final touches on the staffing patterns, we realize that this new model will cost the district $300,000 in additional staff. Suddenly, we are faced with a new systems problem.

This is the way systems work. Look at the automobile. Although it eliminated some of the problems of earlier modes of transportation, it created a new problem, air pollution. Likewise, possible solutions to the problem of the federal deficit create new problems related to taxing and spending policies for this country. And providing ample opportunities for school staff to participate in important decisions generates other problems, such as finding the time to make this happen. Our challenge is to *anticipate* the issues arising from implementing new systems solutions, alert others to the downside of implementing the new solutions, and prepare to accommodate the new problems.

■ ■ ■

In this section, I have outlined seven basic guidelines for applying systems thinking to organizational problems. Although brief guidelines cannot include every aspect of implementing systems thinking, they do provide a framework for moving from theory to practice. By using systems thinking to tackle the challenges of the future, an organization can learn to develop more effective, proactive, and long-term solutions to problems. In the next section, I describe how such an organization might work.

THE ROSENDALE SCHOOL DISTRICT APPLIES SYSTEMS THINKING TO SPECIAL EDUCATION ISSUES

The Rosendale School District is a fictitious yet typical school district facing changing conditions in its special education programs.[1] Current enrollment in the various programs continues to climb at a rate that has school officials worried. Over the past ten years, the number of students in the programs has doubled, and in response, the district has added staff, classrooms, materials, and plenty of headaches.

---

[1] Major credit for developing this case study belongs to friend and colleague William Joy.

This week, the superintendent received a report showing that referral rates this year have increased 15 percent over last year. Superintendent Bellows believes it's time for action. She calls together a group of seven key staff members and explains the conditions. She recommends that the group begin initial problem solving using the guidelines presented in this chapter.

GUIDELINE: FOCUS ON THE SYSTEM, NOT THE PEOPLE.

As the superintendent's ad hoc group starts discussing the special education issue, the conversation quickly turns to puzzling over the pattern of referrals. Which schools are heavy referral schools? Which teachers seem to most readily submit referrals? Who is complaining about the way we are doing business now?

Superintendent Bellows reminds the group that they have lapsed into the old way of doing business. She refocuses the discussion on the system, not the people. She suggests that they begin by developing a common understanding of related history.

GUIDELINE: LEARN HOW THE CURRENT SYSTEM EVOLVED AND HOW IT CONNECTS TO RELATED SYSTEMS.

The Director of Special Services provides a brief history lesson. Over the past twenty years, state and local education agencies have received financial incentives for students qualifying for special education services. The incentives, however, fall far short of the actual costs for special education absorbed by the district. In other words, the special education budget has increased much faster than the overall district budget.

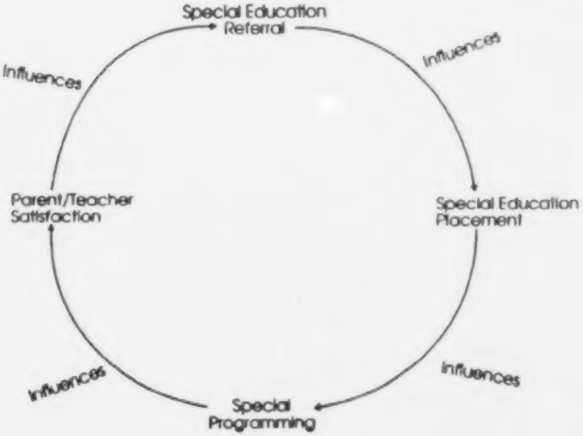
Besides special education legislation and corresponding litigation, another primary but subtle system is influencing special education enrollments: the general education system. With increasing numbers of students at risk for achieving success in school, the general education system has more frequently turned to special education for help. This dependency has produced almost parallel systems within the district.

The Director reminds the group that the district's current system of special education centers on special education teachers providing special instruction to special groups of students in their own special classrooms for most of the school day.

GUIDELINE: EXPECT THE SYSTEM TO RESIST INTERVENTIONS MEANT TO DISRUPT THE STABILITY OF THE CURRENT SYSTEM.

In the Rosendale School District, the system of referrals for special education can be described linearly as follows. A classroom teacher expresses serious concerns about a child's performance and ability to succeed in the regular classroom. The student is referred for placement into a special education program. The student meets stated criteria and is placed in a special education class. The classroom teacher is satisfied that the student's needs will be more appropriately met with special help. The special education teacher is satisfied that he has an opportunity to provide special help. Parents are pleased that the district has been so responsive to the student's needs. The word spreads about how satisfied everyone is with the placement and, not surprisingly, the referral rates escalate across the district. Figure 6.1 outlines the influence relationship occurring. With this cycle of apparent satisfaction and success, why would anyone in their right mind attempt to disrupt the stability of the current system?

FIGURE 6.1
SPECIAL EDUCATION SYSTEMS CYCLE


Special Education Referral
Influences
Special Education Placement
Influences
Special Programming
Influences
Parent/Teacher Satisfaction
Influences

GUIDELINE: EVALUATE THE SYSTEM ACCORDING TO THE ORGANIZATION'S CORE VALUES.

Superintendent Bellows asks the group to consider seriously the question above: Why would anyone want to disrupt the stability of the current system? One of the principals refers to a document on the wall expressing a core value of the district: "You are important, you can succeed, and we will not give up on you." The superintendent recalls that the school board recently approved another core value developed by the district staff that endorses an integrated learning environment as beneficial for *all* students. The Director of Special Services says the district has also pledged that all students will be treated with dignity, respect, and worth.

This discussion spills over into three more meetings focusing on these questions: What do we hold as core values regarding student success for *all* students? Are our practices consistent with our beliefs?

GUIDELINE: LOOK BEYOND THE SYMPTOMATIC PROBLEMS AND SYMPTOMATIC SOLUTIONS TO FUNDAMENTAL SYSTEMS ISSUES.

During the continuing discussion on the topic of special education, someone raises the following question: Is the increase in the number of students receiving special education the problem or a symptom of the problem? The group noted that the intent of the legislation was to ensure that all students with disabilities would be afforded a free, appropriate public education in the least restrictive environment possible. They also thought that the advocates as well as the writers of the legislation could not have anticipated that such a large number of mildly handicapped, underachieving students would be referred and found eligible for special education services.

Not long after the special education legislation was passed, the group noted, student demographics began to change. Classroom teachers faced more diversity and increasingly complex student needs. There was a greater mismatch between teacher expectations and student performance in classrooms in the Rosendale School District. In fact, said the group, this mismatch is really the fundamental problem. Special education, with its accompanying incentives, simply provided a quick fix. The problem-solving group concluded that the quick-fix solution is now pervasive in Rosendale and, by its very nature, has prevented the district from pursuing a more fundamental solution, one that would have a greater, longer lasting effect on the problem.

The group also concluded that the district's core values hold the key for arriving at fundamental solutions. And they pointed out that fundamental solutions have a built-in delay factor; the positive effects of fundamental solutions take much longer to appear than the positive effects of symptomatic solutions. The superintendent cautioned everyone not to be swayed by the temporary relief supplied by quick fixes.

GUIDELINE: THINK WHOLE-SYSTEM, LONG-TERM SOLUTIONS AND REMAIN PATIENT FOR THE SOLUTION TO TAKE EFFECT.

Just as it was necessary to use a systems approach in analyzing the special education issue, it was equally imperative to use a systems approach in applying leverage that would allow the Rosendale School district to implement whole-system, long-term solutions. As an outgrowth of the meetings called by Superintendent Bellows, several district committees accepted the challenge of examining current district practices and recommending a broad set of strategies to address the fundamental problem. Although their work is far from complete, here are some of their preliminary thoughts:

- More broadly educate our entire staff on the board-approved core values and their implications for practice.
- Indicate how the district's commitment to reorganizing by school clusters will have a positive effect on the provision of educational services for *all* children in the school cluster.
- Discuss the implications of site-based management in making decisions about the distribution of resources to best serve students.
- Assure that school-based planning teams represent the perspectives of students with disabilities.
- Outline the necessary staff development needs for *all* staff as fundamental solutions are proposed.
- Remove systems barriers and excuses that block the district's movement to fundamental solutions.
- Remain patient and committed to the core values. Don't take the easy way out!

Committees will continue to add meaning to the above suggestions and then present concrete plans of action so the district can move forward.

GUIDELINE: ANTICIPATE NEW SYSTEMS PROBLEMS ARISING FROM CURRENT SYSTEMS SOLUTIONS.

As organizations methodically engage in systems thinking, they simply cannot afford to dismiss this last guideline. All the progress made can be eroded and even eliminated if the organization fails to anticipate new systems problems. The Rosendale superintendent knows that there will be a significant downside to implementing new solutions. Some of the new difficulties include:

- Rethinking the roles of administrators, special education teachers, and support staff.
- Breaking the dependency relationship between general education and special education.
- Creating additional time for joint problem solving around the needs of individual children.
- Addressing the barriers posed by state bureaucracies and legislation.
- Allaying the fears of parents and teachers who found satisfaction with the old solutions and now fear that gains on behalf of students with disabilities will be lost.
- Using mistakes along the way as excuses to return to the old way of doing business.
- Proving that student performance will be any better under the new system.

Despite these potential problems, the Rosendale staff remains convinced that the core values concerning student success will be better served by the proposed fundamental solutions than by quick fixes. Indeed, with these guidelines and suggested strategies in place, the Rosendale School District is well on its way to using systems thinking to solve fundamental systems issues. By applying the ideas presented in this chapter, your organization could be too.

2

SCIENCE AND MATHEMATICS FOR ALL

Audience:

- Individuals responsible for reform in science and mathematics education.

Desired Outcomes for Participants:

- To increase understanding of equity issues.
- To develop a vision of equity and excellence in science and mathematics education.
- To acquire strategies and resources to develop effective, equitable science and mathematics programs.

Materials:

- **Transparencies:**
  - *Equality* (2-16)
  - *Excellence* (2-17)
  - *Equity* (2-18)
  - *Some Factors Affecting Minority Student Achievement* (2-19)
  - *Factors Affecting Underrepresented, Underserved Students' Achievement* (2-20)
- **Handouts:**
  - *Startling Statements* (2-21 and 2-22)
  - *Answers to Startling Statements* (2-23 and 2-24)
  - *Summary Look at Tomorrow* (2-25 through 28)
  - *The Equitable School Walk* (2-29 through 2-31)
  - *The Equity Jigsaw Focus Questions* (2-32)
- **Readings:**
  - "The Equitable School Continuum" by Raymond M. Rose, Frances A. Kolb, and Nancy Barra-Zuman. Andover, MA: The NETWORK, Inc., 1991.
  - "Worldmath Curriculum: Fighting Eurocentrism in Mathematics" by S. E. Anderson. *Journal of Negro Education*, Summer 1990, 59 (3): 348-359.
  - "Transforming the Mainstream Curriculum" by James A. Banks. *Educational Leadership*, May 1994, 51 (8): 4-8.

- "Bias Against Girls Found Rife in Schools, With Lasting Damage" by Susan Chira. *New York Times* Education Section, February 12, 1992.
- "Classroom Factors" from *Mathematics and Science: Critical Filters for the Future of Minority Students* by DeAnna Banks Beane. Chevy Chase, MD: Mid-Atlantic Equity Center, 1988, 16-18.
- "The Road Less Traveled by Girls" by Natalie Carter Holmes. *The School Administrator*, December 1991, 48 (11): 8-11, 14, 16-19.
- "Science in the American Education" by Nancy Kober. *EDTALK: What We Know About Science Teaching and Learning*. Washington, DC: Council for Educational Development and Research, 1991, 3-5.
- "Summary and Implications: Student- and Teacher-Related Factors Influencing Minority Student Participation and Performance" from *Mathematics and Science: Critical Filters for the Future of Minority Students* by DeAnna Banks Beane. Chevy Chase, MD: Mid-Atlantic Equity Center, 1988, 19-24.
- "Checklist for Equity in Mathematics and Science" from *Mathematics and Science: Critical Filters for the Future of Minority Students* by DeAnna Banks Beane. Chevy Chase, MD: Mid-Atlantic Equity Center, 1988, 30-32.

- Overhead projector, screen, and overhead pens
- Newsprint, easels, markers, scissors, tape, blank paper, and pens or pencils

---

Time Required:

- Awareness Exercises: Three hours
- Visualizing Exercises: Three hours
- Empowering Exercises: Three hours

Facilitator's Notes: Equity is an integral component of systemic change. Student achievement in science and mathematics is a national concern and reforms are intended to address the concerns across all gender, race, economic, and ethnic lines. This is far easier said than done. Systemic change in the schools cannot occur without paying *special* attention to issues of equity. Equity must be addressed in terms of access, participation, and successful achievement in all content areas, especially in science and mathematics.

A 1990 National Assessment of Educational Progress (NAEP) study reports that a significant number of students do not possess in-depth scientific knowledge, nor have they generally mastered mathematics skills beyond the fifth grade. By the time students are seniors in high school, only half can correctly calculate simple mathematics problems using decimals, fractions, or percents (National Center for Education Statistics 1991).

Any examination of statistics concerning science and mathematics achievement of female and minority students reveals the same grim news. Although minorities and females enter school roughly equal in measured ability to white male students, by the time minorities and females are seniors in high school, they have mastered only the basic arithmetic skills (National Center for Education Statistics 1992, 118). The National Assessment Governing Board reported that only 2 percent of 12th grade African-American students are competent in 12th grade mathematics. The same holds true for 6 percent of the Hispanic students, 19 percent of the white students and 34 percent of the Asian/Pacific Islander students (National Goals Panel 1991, 28). Students who *are* competent in 12th grade mathematics can identify geometric shapes, measure lengths and angles, and calculate areas of rectangles. They have developed the skills to operate with signed numbers, exponents, and square roots, and their reasoning and problem-solving skills are well developed (Bourque and Garrison 1991).

In science the minority and gender gaps are even more pronounced. While the percentage of high school students who "look forward to science class" is roughly the same within each group (African-American 68 percent, Hispanics 67 percent, Native American 64 percent, white 60 percent) (U.S. Department of Education 1990a, 131), women account for 11 percent of the scientists and engineers in the United States; African-Americans and Hispanics account for only 4 percent (U.S. Department of Education 1990b, 2). A 1992 report, *Minorities in Higher Education*, revealed that 79 percent of the Bachelor's degrees in biological sciences were earned by white students, 9 percent by Asian, 5 percent by African-Americans, 3 percent by Hispanics and 0.4 percent by Native Americans (American Council on Education 1992, 57-60). A study of high school seniors found that 12 percent more males than females take physics and calculus. Of those students, 64 percent of the males plan to major in science or engineering in college, compared to only 18.6 percent of the females (Commission on Professionals in Science and Technology 1992).

With these statistics in mind, this activity was developed for the purpose of bringing together the research and expertise needed to understand and develop means to achieve excellence and equity within the school environment. Exercises are arranged into three parts designed to:

- assist participants in understanding what the equity issues are;

- help participants to envision what could be done to achieve equity; and

- empower participants with strategies and resources to increase equity in science and mathematics education.

Equity is a "thread" that weaves through all of the activities of the *Toolkit*. Without addressing equity as an integral component of each exercise, we fail to focus on the real issue of educational reform efforts: equality of educational excellence, especially in science and mathematics, for all students.

Not everyone is familiar with equity issues; therefore, it is important for the facilitator to read the materials included within each exercise and some from the **Additional References** on pages 2-11 through 2-15. The more you know about the issues, the more meaningful the discussions, and the deeper the experience will be for the participants.

Each exercise has its own Process notes to guide you in facilitating these activities:

- Awareness exercises
  - startling statements
  - defining equality, excellence, and equity
- Envisioning exercises
  - a diversity fantasy
  - the Equitable School Walk
- Empowering exercises
  - the equity jigsaw
  - equity in science and mathematics

Process: AWARENESS EXERCISES

These exercises help increase the participants' awareness of equity issues in science and mathematics education and to build a shared definition of equality, excellence, and equity.

Startling Statements

1. In preparation for this exercise, cut a copy of the handout **Startling Statements (2-21 and 2-22)** into strips, one question per strip. Explain that this exercise is intended to increase participants' awareness of equity issues in science and mathematics education and increase their knowledge of the status of academic preparation for scientific, mathematics, and technology careers of underserved and underrepresented groups at all levels. *Note:* This kind of exercise was originally developed by the Lawrence Hall of Science at Berkeley.

2. Roam the room. Tape one strip with a startling statement question on each participant's back. Several participants may have the same question, depending on the number present.

   Have the participants stand, walk around the room, and ask five other participants for the answer to the question on their back. Once each participant has five answers, he/she should sit down and find the average and range of the five answers.

3. Distribute the handout **Startling Statements (2-21 and 2-22)**. Read a question and ask who thinks they had that question on their back. Have them share why they think that, and ask them to give their answer and range. Then give the correct answer. Continue until all of the questions have been answered. Distribute the handout **Answers to Startling Statements (2-23 and 2-24).**

   Discuss: Who is underrepresented and underserved? What patterns of inequity do we see?

Defining Equality, Excellence, and Equity

4. Explain the Pyramidal Process for Reaching Consensus (see **Appendix B-5**). In groups of four, ask participants to share their meanings for *equality, excellence*, and *equity*. Have them record their answers and reflect on the relationships they see among them.

   Next, combine the groups of four into groups of eight and ask them to come to consensus on the three definitions. Continue combining groups until the entire room is working together and shares a common definition of the three terms. Record definitions on newsprint once the large group has reached consensus.

   Note that the process by which they reached consensus in small groups and then combined groups until all had reached agreement is a style of decision making used by many cultural groups. It closely parallels the governing style of the Iroquois Nation and several other Native American groups, for example.

5. Use the **Equality**, **Excellence**, and **Equity (2-16 through 2-18)** transparencies to discuss each term and some examples of each. Relate to the definitions they already developed and ask for additional examples.

   - *Equality* refers to treating all students the same, regardless of differences. Some examples are:
     - requiring all students to take a particular course or complete the same assignment
     - using the same criteria to assess each student's work
     - taking the same disciplinary action for the same rule infraction
   - *Excellence* refers to achieving at the highest level of mastery. Some examples are:
     - having high expectations for all students
     - setting ambitious learning goals as standards for all students
   - *Equity* refers to treating students fairly by taking into account significant differences. Some examples are:
     - allowing students to demonstrate mastery in different ways
     - giving some students a handicap in sports activities to level the competitive field
     - providing selected students with more teacher time and assistance to help achieve mastery

6. Discuss how any component of the school/classroom environment needs to be flexible (e.g., varying instructional formats along the lines of whole class, group, individual work, etc.) to achieve equity.

71

ENVISIONING EXERCISES

Envisioning exercises help the participant see what could be done to achieve equity in science and mathematics education.

Diversity Fantasy

7. The Diversity Fantasy technique is intended to develop or enhance the participants' skill in recognizing diversity within the classroom. It should lead to the recognition that diversity includes learning styles, gender, race and ethnicity, disability, culture, socioeconomic status, language, and a wide variety of other factors that influence how students learn and process information. Be aware that some groups may be resistant to this kind of exercise, although it does provide a valuable alternative way of learning. It may help to call it a visualization or mental walk-through. It is important that you, as facilitator, be comfortable with it before doing it.

8. Tell participants that you are going to take them on a guided fantasy. To do this, all they need to do is close their eyes and let their mind be guided by the prompts you give them. You will ask them some questions but they need only respond in their mind. Your voice should be the only voice heard during the exercise.

   When participants have closed their eyes, ask them to relax their bodies and focus on their breathing. Once relaxed, ask participants to think about their particular work situation (their classroom, school, district, state, etc.). You may want them to imagine a real location, such as a lunchroom.

   Ask participants to think about the students in this situation. Ask them to focus on the *diversity* of the students. Ask them to think of as many ways as they can in which these students are diverse. Give them plenty of time to do this. During this time, offer additional prompts such as "In what ways are the students different from one another?" and "Are there any other characteristics that distinguish one student from another?"

9. Ask participants to picture a particular student, one the system does not seem to be working for. Ask them to think about this student and other diverse students while they consider the following questions:

   - Do you believe that *all* those students can learn?

- Do you believe that all those students can not only learn but learn to high levels of achievement?
- What is being done or can be done to make this happen?

Ask participants to hold those thoughts and think about coming back to the session ("reality").

Tell participants that, on the count of three, they may open their eyes and rejoin the session. Slowly count "One, two, three."

10. Solicit and record the diverse types of students they thought of on newsprint; add other groups not mentioned that you wish to include (e.g., male/female, religious affiliation, sexual orientation, socioeconomic status/class, speakers of different languages, etc.). You may wish to discuss ways to cluster the list (e.g., physical, mental, or background attributes).

11. Distribute the handout **Summary Look at Tomorrow (2-25 through 2-28)**. Ask participants to work in small groups to compare their "fantasies" to these real world statistics.

    Emphasize that, especially for public school educators, we are entrusted with meeting the educational needs of *all* these students. Ask groups to discuss strategies that are being implemented to meet these needs so *all* these students can indeed learn to high levels. Have groups report out and record on newsprint.

The Equitable School Walk

12. Divide the participants into five or six small groups. Have them listen to the following prompt:

    For the next hour or so I am going to ask you to become equity consultants. Your first job is to visit a school that is considered a model equitable school. Other consultants who have been there before you have praised it on many counts and say that students, teachers, and all school personnel are treated equitably. The school attempts in many ways to overcome the harmful results of bias and discrimination on the basis of gender, ethnic group, or disability. You are being paid well for your time and plan to take good notes about what you see in this school. I am your guide and I am going to take you through the building. In order to get a frame of reference, picture a school you are familiar with, perhaps one you attended as a child, or one that you currently *work in or with. You may want to give the school a name. Decide on the grade level of the students in this building.*

13. Distribute the handout **The Equitable School Walk (2-29 through 2-31)**. Assign each group two components (component names are centered after each item). Using the handout prompts as a guide, have the participants describe the component they are assigned and record on newsprint. Ask them to think specifically about each item with respect to science and mathematics.

14. An alternative method of doing this same exercise is to have participants number a piece of paper from 1 to 11 with a 10a and 10b and plenty of space in between each number. Using the handout **The Equitable School Walk**, the facilitator reads each component and allows participants to reflect and write their responses individually. The groups are assigned their components, members pool their ideas for each, and create a newsprint description for each component.

15. After each group completes the description of their assigned component, tape the newsprint around the room, in order, to form a storyboard. Have participants share their vision of each component. If necessary, push them for science and mathematics examples. Other groups should feel free to contribute additional ideas to the discussion.

16. Distribute the reading "The Equitable School Continuum" and ask each group to look at the components that they discussed, noting the progression from the unacceptable to the ideal conditions. Ask for comments on what is missing from their own descriptions, what they take issue with, what ideas they have for use of such a continuum. Be sure the discussion focuses on science and mathematics as much as possible.

EMPOWERING EXERCISES

These exercises were selected to provide strategies and resources that will enhance the participant's ability to increase equity in science and mathematics education.

The Equity Jigsaw

17. Select four of the articles (listed second through seventh) from the readings. Note that some of the articles have controversial points of view and may not be appropriate for all audiences, therefore, select carefully. Using the jigsaw technique (see **Appendix B-3**),

divide the participants into groups of four. Explain that each group member will be responsible for reading and briefing the others on one of the four articles listed at the beginning of this activity.

18. When participants have finished reading, have them each share the key points of their article (four to five minutes each). Then distribute the handout **The Equity Jigsaw Focus Questions (2-32)** and ask them to discuss the questions in light of the articles that they have just read.

19. Using the focus questions, ask for suggestions for addressing each of the issues. Record these on newsprint by question.

20. Distribute the reading "Summary and Implications: Student- and Teacher-Related Factors Influencing Minority Student Participation and Performance" and point out the affective and cognitive factors that influence minority student participation and performance. Ask the question: Which did not occur on the list that the participants have just generated?

Equity in Science and Mathematics

21. Summarize the affective and cognitive factors using the **Some Factors Affecting Minority Student Achievement (2-19)** and/or **Factors Affecting Underrepresented, Underserved Students' Achievement (2-20)** transparencies.

22. Begin with the question: Who's underrepresented (or underserved)? Allow the participants a few minutes to answer this question with a partner. They will use the information that emerges from this discussion to complete the rest of the activity.

    After defining the underrepresented/underserved population, distribute the reading "Checklist for Equity in Mathematics and Science." Allow about 15 minutes for each participant to complete the checklist.

23. Using the checklist as a guide, have the participants work in twos or threes to develop a list of next steps they may want to take to learn more or develop strategies to address some of the questions on the checklist.

    Note: The instrument was developed with principals and district administrators in mind. However, it can be easily adopted for use by others. Each part of the checklist may or may not be appropriate for use, depending on the audience. It is important to point out to participants that the purpose of the checklist is to have them each assess their own participation in promoting equity. Its purpose is *not* to evaluate or judge.

24. Ask participants to look at their definitions of systemic change generated in **Activity 1: Framing the Dialogue Around Systemic Change**. Ask them to discuss in small groups, then share with whole group:

    - What bearing do the issues of equity addressed in this activity have on your definition of systemic change?
    - How is each element in your definition sharpened when you consider the need to increase equity?

25. Ask participants to reflect on, talk about, and/or write: What have I learned in this activity? How can I use what I have learned?

Additional References:

American Association of University Women Educational Foundation and Wellesley College Center for Research on Women. 1992. *The AAUW Report: How Schools Shortchange Girls*. Washington, DC: AAUW.

American Council on Education. 1992. *Minorities in Higher Education*. Washington, DC: American Council on Education.

Baptiste, Prentice, ed. 1990. *Leadership, Equity, and School Effectiveness*. Newbury Park, CA: Sage/Corwin Press.

* Beane, DeAnna Banks. 1988. *Mathematics and Science: Critical Filters for the Future of Minority Students*. Chevy Chase, MD: Mid-Atlantic Consortium for Equity.

* ________________. 1992. *Opening Up the Mathematics and Science Filters*. Chevy Chase, MD: Mid-Atlantic Consortium for Equity.

Blank, Rolf K. and Melanie Dalkilic. 1991. *State Indicators of Science and Math Education, 1990*. Washington, DC: Council of Chief State School Officers, State Education Assessment Center.

---

*These are considered "must-reads" for those with more interest and not much time.

Bourque, Mary Lynn and Howard Garrison. 1991. *The Levels of Mathematics Achievement: Initial Performance Standards for the 1990 NAEP Mathematics Assessment, Vol. 1, National and State Summaries*. Washington, DC: National Assessment Governing Board.

Campbell, Patricia B. March 1986. "What's a Nice Girl Like You Doing in Math Class?" *Phi Delta Kappan* 67 (7): 516-520.

____________________. Winter 1989. "So What To Do with the Poor, Non-White Female? Issues of Gender, Race, and Social Class in Mathematics and Equity." *Peabody Journal of Education* 66 (2): 95-112.

____________________. 1991. "Math, Science and Too Few Girls: Enough Is Known for Action." Documentation developed under the auspices of The Women's Educational Equity Act by Campbell-Kibler Associates, Groton, MA.

Clewell, Beatriz Chu and Bernice T. Anderson. 1991. *Women of Color in Mathematics, Science, and Engineering: A Review of the Literature*. Washington, DC: Center for Women Policy Studies.

Cocking, Rodney R. and Jose P. Mestre. 1988. *Linguistic and Cultural Influences on Learning Mathematics*. Hillsdale, NJ: Erlbaum.

Countryman, Joan. 1992. *Writing to Learn Mathematics: Strategies That Work, K-12*. Portsmouth, NH: Heinemann Press.

Davis, Josephine D. 1989. "The Mathematics Education of Black High School Students." In Willie Pearson, Jr. and H. Kenneth Bechtel, eds. *Blacks, Science, and American Education*. New Brunswick, NJ: Rutgers University Press.

Escalante, Jaime. 1990. *The Jaime Escalante Math Program*. Washington, DC: National Education Association.

Fennema, Elizabeth and Gilah C. Leder. 1990. *Mathematics and Gender*. New York: Teachers College Press.

Fort, Deborah C. and Heather L. Varney. May 1989. "How Students See Scientists: Mostly Male, Mostly White, and Mostly Benevolent." *Science and Children* 26 (8): 8-13.

Garcia, Jesus; N. R. Harrison; and J. L. Torres. 1990. "The Portrayal of Females and Minorities in Selected Elementary Mathematics Series." *School Science and Mathematics* 90 (1): 2-12.

Grayson, Dolores A. and Mary D. Martin. 1990. *Gender/Ethnic Expectations and Student Achievement*. Earlham, IA: Gray Mill.

* Hanson, Katherine. 1992. "Teaching Mathematics Effectively and Equitably to Females." *Trends and Issues 17*. New York: ERIC Clearinghouse on Urban Education, Teachers College, Columbia University.

Hart, Phyllis and Maryann Jacobi. 1992. *From Gatekeeper to Advocate: Transforming the Role of the School Counselor*. New York: The College Board.

Kahle, Jane Butler and Marsha K. Lakes. February 1983. "The Myth of Equality in Science Classrooms." *Journal of Research in Science Teaching* 20 (2): 131-140.

Kober, Nancy. 1991. *EDTALK: What We Know About Mathematics Teaching and Learning.* Washington, DC: Council for Educational Development and Research.

___________. 1992. *EDTALK: What We Know About Science Teaching and Learning.* Washington, DC: Council for Educational Development and Research.

Kreinberg, Nancy. Winter 1989. "Needed: An Agenda for Equity in Mathematics Education." *Peabody Journal of Education* 66 (2): 127-146.

Levin, Tamar; Naama Sabar; and Zipora Libman. 1991. "Achievements and Attitudinal Patterns of Boys and Girls in Science." *Journal of Research in Science Teaching* 28 (4): 315-328.

Mason, Cheryl; Jane Butler Kahle; and April Gardner. May-June 1991. "Draw-a-Scientist Test: Future Implications." *School Science and Mathematics* 91 (5): 193-198.

McCloskey, Wendy and Rita O'Sullivan. June 1993. *How To Assess Student Performance In Science: Going Beyond Multiple Choice Tests.* Greensboro, NC: SouthEastern Regional Vision for Education.

Mid-Atlantic Consortium for Equity. 1992. *Introducing African American Role Models into Mathematics and Science Lesson Plans: Grades K-6.* Chevy Chase, MD: Mid-Atlantic Consortium for Equity.

Mullis, Ina V. S.; John A. Dossey; Eugene H. Owen; and Gary W. Phillips. 1991. *The State of Mathematics Achievement: NAEP's 1990 Assessment of the Nation and the Trial Assessment of the States.* Washington, DC: U.S. Department of Education.

National Center for Education Statistics. 1991. *Trends in Academic Progress: Achievement of American Students in Science, 1960-1990, Mathematics, 1973-1990.* Washington, DC: National Center for Education Statistics.

____________________. 1992. *Digest for Educational Statistics.* Washington, DC: National Center for Education Statistics.

National Coalition for Women and Girls in Education. 1992. *The Task Force Reports: Teaching Strategies for Girls in Math and Science.* Washington, DC: National Coalition for Women and Girls in Education.

National Education Goals Panel. 1991. *National Education Goals Report.* Washington, DC: National Education Goals Panel.

National Science Board. 1991. *Science and Engineering Indicators.* Washington, DC: National Science Board.

* National Science Foundation. 1990. *Women and Minorities in Science and Engineering.* Washington, DC: National Science Foundation.

____________________. 1992a. *Blacks in Undergraduate Science and Engineering Education.* Washington, DC: National Science Foundation.

____________________. 1992b. *Women and Minorities in Science and Engineering Education.* Washington, DC: National Science Foundation.

Nicholson, Heather Johnson. July 1987. "Equity on Purpose: In Pursuit of Excellence in Informal, Out-Of-School Interventions in Math, Science, and Technology." Paper presented at the Conference of Vision to Reality, Ann Arbor.

* Oakes, Jeannie. 1990. *Lost Talent: The Underparticipation of Women, Minorities, and Disabled Persons in Science.* Santa Monica, CA: RAND Corporation.

* Orenstein, Peggy. 1994. *School Girls: Young Women, Self-Esteem and the Confidence Gap.* New York: Doubleday and Washington, DC: American Association of University Women.

Powell, Mary Jo. 1994. *Equity in the Reform of Mathematics and Science Education*. Austin: Southwest Educational Development Laboratory.

Reyes, Laurie Hart and George M.A. Stanic. 1988. "Race, Sex and Math." *Journal of Research in Math Education* 19 (1): 26-43.

Sadker, Myra and David Sadker. 1994. *Failing at Fairness: How America's Schools Cheat Girls*. New York: Charles Scribner's Sons.

Strauss, Mary Jo; Susan Shaffer; Joyce Kaser; and Kathryn Shaw. 1991. *Gender Bias in Mathematics, Science and Technology. The Report Card #3*. Chevy Chase, MD: The Mid-Atlantic Center and Andover, MA: The NETWORK, Inc.

Tobias, Randolph. 1992. *Nurturing At-Risk Youth in Math and Science*. Bloomington, IN: National Educational Services.

Tocci, Cynthia, and George Engelhard. May-June 1991. "Achievement, Parental Support, and Gender Differences in Attitudes Toward Mathematics." *Journal of Educational Research* 84 (5): 280-286.

U.S. Department of Education. 1990a. *Digest for Educational Statistics*. Washington, DC: U.S. Department of Education.

__________________. 1990b. *What Schools Can Do To Improve Math and Science Achievement by Minority and Female Students*. Washington, DC: U.S. Department of Education, Office for Civil Rights.

EQUALITY

Treating all students the same

Examples:

- same required courses
- same assignments
- same assessment criteria
- same disciplinary actions

EXCELLENCE

Achieving at the highest level

Examples:

- high expectations
- high standards

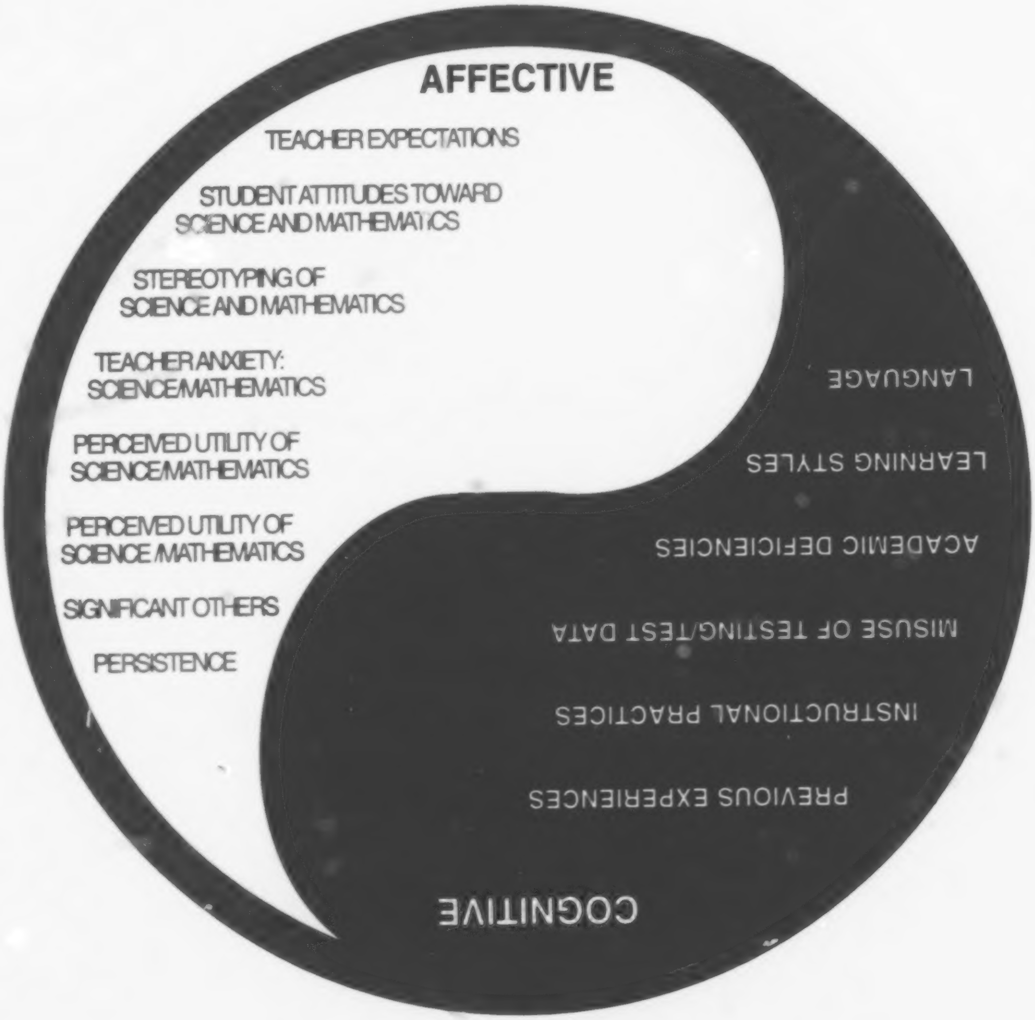
EQUITY

Treating students fairly
by considering differences

Examples:

- different ways to demonstrate mastery
- handicaps for sports
- more teacher time and help

SOME FACTORS AFFECTING MINORITY STUDENT ACHIEVEMENT



AFFECTIVE

TEACHER EXPECTATIONS

STUDENT ATTITUDES TOWARD SCIENCE AND MATHEMATICS

STEREOTYPING OF SCIENCE AND MATHEMATICS

TEACHER ANXIETY: SCIENCE/MATHEMATICS

PERCEIVED UTILITY OF SCIENCE/MATHEMATICS

PERCEIVED UTILITY OF SCIENCE /MATHEMATICS

SIGNIFICANT OTHERS

PERSISTENCE

COGNITIVE

PREVIOUS EXPERIENCES

INSTRUCTIONAL PRACTICES

MISUSE OF TESTING/TEST DATA

ACADEMIC DEFICIENCIES

LEARNING STYLES

LANGUAGE

FACTORS AFFECTING UNDERREPRESENTED, UNDERSERVED STUDENTS' ACHIEVEMENT

Students: Affective Factors

- Perceived utility of science and mathematics
- Attitudes toward science and mathematics
- Stereotyping of science and mathematics
- Influence of significant others
- Persistence

Students: Cognitive Factors

- Misuse of testing/test data
- Academic deficiencies
- Previous experiences
- Learning styles
- Language

Classroom Factors: Cognitive and Affective

- Teacher anxiety: science/mathematics
- Instructional practices
- Teacher expectations

STARTLING STATEMENTS*

1. On the 1990 National Assessment of Educational Progress (NAEP-90), in grade 4, more than 80% of white and Asian-American students demonstrated proficiency with third grade mathematics content (level 200). What percentage of African-American and Hispanic students could demonstrate the same proficiency? __________

2a. According to the NAEP-90, at grade 8, 86% of the Asian-American students and 77% of the white students exhibited proficiency with the mathematics curriculum generally associated with the 5th grade level (level 250). What percentage of Hispanic students could do the same? __________

2b. According to the NAEP-90, at grade 8, 86% of the Asian-American students and 77% of the white students exhibited proficiency with the mathematics curriculum generally associated with the 5th grade level (level 250). What percentage of African-American students could do the same? __________

3a. According to the NAEP-90, most 4th graders have mastered the 4th grade mathematics curriculum. What is the average grade level mathematics proficiency for 8th graders? __________

3b. According to the NAEP-90, most 4th graders have mastered the 4th grade mathematics curriculum. What is the average grade level mathematics proficiency for 12th graders? __________

4. The National Council of Teachers of Mathematics (1989) *Curriculum and Evaluation Standards for School Mathematics* states "all students will have a calculator."

   What percentage of grade 8 students reported having unrestricted use of calculators in their math classes? __________

5a. Using the NAEP-90 to compare average science proficiency levels of students, it was found that the average 13 year old African-American student scored at about the same level of proficiency as a white student of what age? _________

---

*This kind of activity was originally developed by the Lawrence Hall of Science, Berkeley, CA.

STARTLING STATEMENTS (continued)

5b. Using the NAEP-90 to compare average science proficiency levels of students, it was found that the average 17 year old African-American student scored at about the same level of proficiency as a white student of what age? ________

6. How many of the 2054 living members of the National Academy of Sciences are women? ________

7. What percentage of high school mathematics teachers majored in mathematics? ________

8a. According to the Council of Chief State School Officers in 1989: Out of every ten elementary school teachers, how many are female? ________

8b. According to the Council of Chief State School Officers in 1989: Out of every ten teachers in grades 7 through 12, how many are female? ________

8c. According to the Council of Chief State School Officers in 1989: What percentage of mathematics teachers in grades 7 through 12 are male? ________

8d. According to the Council of Chief State School Officers in 1989: What percentage of Biology and Chemistry teachers in grades 7 through 12 are male? ________

8e. According to the Council of Chief State School Officers in 1989: What percentage of Physics teachers are male? ________

9a. On the 1990 NAEP students at grades 4, 8, and 12 were asked if they agreed or disagreed with the statement "I am good at mathematics." At grades 4 and 8, out of 10 students, how many agreed or strongly agreed that they were good at mathematics? ________

9b. On the 1990 NAEP students at grades 4, 8, and 12 were asked if they agreed or disagreed with the statement "I am good at mathematics." At grade 12, out of 10 students, how many felt that they were good at mathematics? ________

STARTLING STATEMENTS (continued)

10. What percentage of Native Americans in urban high schools drop out before graduating? __________

11. What percent of the 50 state school superintendents are women? __________

12. What percent of the 24 members of the National Science Board are women? __________

ANSWERS TO STARTLING STATEMENTS*

1. On the 1990 National Assessment of Educational Progress (NAEP-90), in grade 4, more than 80% of white and Asian-American students demonstrated proficiency with third grade mathematics content (level 200). What percentage of African-American and Hispanic students could demonstrate the same proficiency? **50% or less**

2. According to the NAEP-90, at grade 8, 86% of the Asian-American students and 77% of the white students exhibited proficiency with the mathematics curriculum generally associated with the 5th grade level (level 250).

   a. What percentage of Hispanic students could do the same? **47%**

   b. What percentage of African-American students could do the same? **36%**

3. According to the NAEP-90, most 4th graders have mastered the 4th grade mathematics curriculum.

   a. What is the average grade level mathematics proficiency for 8th graders? **Grade 5**

   b. What is the average grade level mathematics proficiency for 12th graders? **Grade 7**

4. The National Council of Teachers of Mathematics (1989) *Curriculum and Evaluation Standards for School Mathematics* states "all students will have a calculator."

   What percentage of grade 8 students reported having unrestricted use of calculators in their math classes? **19%**

5. Using the NAEP-90 to compare average science proficiency levels of students, it was found that:

   a. The average 13 year old African-American student scored at about the same level of proficiency as a white student of what age? **9**

   b. The average 17 year old African-American student scored at about the same level of proficiency as a white student of what age? **13**

6. How many of the 2054 living members of the National Academy of Sciences are women? **76%**

---

*This kind of activity was originally developed by the Lawrence Hall of Science, Berkeley, CA.

ANSWERS TO STARTLING STATEMENTS (continued)

7. What percentage of high school mathematics teachers majored in mathematics? **42%**

8. According to the Council of Chief State School Officers in 1989:

   a. Out of every ten elementary school teachers, how many are female? **8**

   b. Out of every ten teachers in grades 7 through 12, how many are female? **5**

   c. What percentage of mathematics teachers in grades 7 through 12 are male? **50%**

   d. What percentage of Biology and Chemistry teachers in grades 7 through 12 are male? **66%**

   e. What percentage of Physics teachers are male? **75%**

9. On the 1990 NAEP students at grades 4, 8, and 12 were asked if they agreed or disagreed with the statement "I am good at mathematics."

   a. At grades 4 and 8, out of 10 students, how many agreed or strongly agreed that they were good at mathematics? **6**

   b. At grade 12, out of 10 students, how many felt that they were good at mathematics? **5**

10. What percentage of Native Americans in urban high schools drop out before graduating? **85%**

11. What percent of the 50 state school superintendents are women? **18%**

12. What percent of the 24 members of the National Science Board are women? **4%**

SUMMARY LOOK AT TOMORROW

- In 2010, four states (New York, Texas, California, and Florida) will have about one-third of the nation's youth, and more than half will be "minority." The REAL minority will be non-Hispanic white youth in these key states. What will we call "minorities" when they are more than half of the population? And, how will these states interact with Maine which will have three percent minority youth in 2010?
- In the 1960s, housing moved to the suburbs. In the 1980s, so did everything else: jobs, churches, colleges, movies, and shopping. How can cities survive if we define being successful as moving to a suburb? What would it take to get middle income people to move back to the city? Many "urban" problems – crime, drugs, poverty, violence – will continue to spread to the suburbs. How can we govern a metro area which includes both cities and their now dominant suburbs?
- Some 82 percent of all children now have working mothers. Business and government must respond to the rapidly increasing demand for child care. Fifteen million women are raising children without the father present at an income level $400 over the poverty line. Sixty percent of all children will spend some time with a single parent before reaching age 18, making the single parent family the new "typical American family."
- The U. S. population is aging rapidly. There are 30 million people over age 65, increasing to 65 million by 2020. Many will have one year of retirement for every year of work. Children under age 18 (34 percent of our population in 1970), become 25 percent in 2000. Yet, at a time when children are increasingly scarce, about 30 percent of the kids in 1992 are at a serious risk of failure in school and in life.
- With the establishment of sizeable populations of middle class blacks, Hispanics, and Asians, many racial problems are actually issues of race AND class. The single factor that holds the most children back is poverty, regardless of race.
- The U.S. population increased ten percent between 1980 and 1990; the prison population exploded by 139 percent. Prisoners cost the taxpayers over $20,000 each annually and 80 percent are high school dropouts. We now lead the world in the percentage of our population behind bars. One prisoner takes away the money for SIX children in Head Start programs.

Source: Reprinted with permission of the Institute for Educational Leadership from *A Demographic Look at Tomorrow* by Harold Hodgkinson. ©1992.

SUMMARY LOOK AT TOMORROW (continued)

- The "middle" of our society is declining, while rich and poor are increasing. We are creating two work forces: one in minimum wage jobs, the other in well-paying jobs. For every new job created for a computer programmer, eight new jobs are created for food service workers. This leads to an "information-rich" and "information-poor" split in our society.
- If you are concerned about the test scores of U.S. students compared to the test scores of Asian students, try looking at the test scores of U.S. *inner city* students compared to the scores of U.S. *suburban* students.

SUMMARY LOOK AT TOMORROW (continued)

Total Children Under Age 18 and Minority* Youth As A Percent of the Total Youth Population by State 1990 and Projections for 2000 and 2010

(Ranked by Percent Minority in 2010)

State	1990		2000		2010	
	Total Children Under Age 18 (000)	Percent Minority	Total Children Under Age 18 (000)	Percent Minority	Total Children Under Age 18 (000)	Percent Minority
United States	63,604	31.1	65,717	34.0	62,644	38.2
District of Columbia	117	87.2	111	90.9	105	93.2
Hawaii	280	72.5	296	76.4	310	79.5
New Mexico	447	60.2	569	70.0	595	76.5
Texas	4,836	49.1	5,415	51.9	5,418	56.9
California	7,751	54.1	8,402	51.4	8,520	56.9
Florida	2,866	36.2	3,244	48.6	3,270	53.4
New York	4,260	37.9	4,189	45.8	3,862	52.8
Louisiana	1,227	41.6	1,229	47.3	1,118	50.3
Mississippi	747	46.7	791	48.8	749	49.9
New Jersey	1,799	33.1	2,037	40.2	1,935	45.7
Maryland	1,162	35.8	1,267	40.2	1,220	42.7
Illinois	2,946	32.7	2,947	36.8	2,684	41.7
South Carolina	920	39.8	968	39.6	931	40.1
Georgia	1,727	36.7	2,056	36.4	2,116	37.9
Arizona	981	40.3	1,191	33.6	1,229	37.1
Delaware	163	26.8	179	32.9	177	37.0
Alabama	1,059	34.2	1,111	34.8	1,046	35.6
Nevada	297	28.0	286	30.0	288	33.4
North Carolina	1,606	31.9	1,723	32.3	1,684	33.2
Colorado	861	25.4	924	28.9	893	33.1
Alaska	172	31.7	201	29.5	208	32.7
Virginia	1,505	28.7	1,607	29.4	1,549	31.1
Michigan	2,459	22.3	2,347	25.5	2,094	29.2
Oklahoma	837	25.7	838	24.8	795	27.5
Connecticut	750	23.4	781	23.4	715	27.0
Arkansas	621	24.3	621	26.1	576	26.8

-continued-

SUMMARY LOOK AT TOMORROW (continued)

Total Children Under Age 18 and Minority* Youth As A Percent of the Total Youth Population by State 1990 and Projections for 2000 and 2010

(Ranked by Percent Minority in 2010)

State	1990		2000		2010	
	Total Children Under Age 18 (000)	Percent Minority	Total Children Under Age 18 (000)	Percent Minority	Total Children Under Age 18 (000)	Percent Minority
Tennessee	1,217	22.5	1,204	24.1	1,125	25.3
Ohio	2,800	16.2	2,631	18.6	2,349	20.8
Wyoming	136	11.8	137	17.8	125	20.2
Missouri	1,315	16.6	1,331	18.5	1,236	19.9
South Dakota	198	13.9	193	16.2	180	19.8
Washington	1,261	17.9	1,163	16.9	1,098	19.5
Kansas	662	15.3	633	17.1	585	19.3
Indiana	1,456	13.3	1,382	16.7	1,242	19.2
Pennsylvania	2,795	16.1	2,609	16.7	2,260	18.7
Rhode Island	226	16.3	236	15.5	222	18.6
Massachusetts	1,353	17.9	1,368	15.5	1,267	18.2
Oregon	724	12.8	677	14.1	637	16.8
Wisconsin	1,289	13.5	1,208	13.7	1,067	16.6
Montana	222	12.0	198	13.2	181	15.4
Kentucky	954	10.2	906	12.6	818	14.1
Nebraska	429	10.4	398	10.8	358	13.1
Utah	627	9.7	715	11.2	740	12.4
Minnesota	1,167	9.8	1,138	9.1	1,042	11.2
Idaho	308	10.1	291	9.4	275	11.0
North Dakota	175	9.1	157	8.6	138	10.0
Iowa	719	5.8	622	7.0	529	8.7
West Virginia	444	4.9	401	6.7	344	7.3
New Hampshire	279	3.4	329	4.8	317	5.5
Vermont	143	2.4	150	4.7	138	5.4
Maine	309	2.8	310	3.0	284	3.1

*Minority include blacks, Asians and Pacific Islanders, Native Americans and Alaskan Natives, and other races as well as white Hispanics. The projections for all minorities were derived by American Demographics.

Source: 1990 - Bureau of the Census; and 2000 and 2010 projections from "Projections of the Population of States by Age, Sex and Race: 1988 to 2010," by Signe I. Wetrogen, Bureau of the Census as cited in American Demographics, May 1989.

THE EQUITABLE SCHOOL WALK

1. As we walk up to the building and through the set of double doors, the first thing you see is a large display area and bulletin board. It extends the length of the hall, which is about the length of this wall. **Considering that this school is a model of equity, what have you noticed that gives you the immediate impression that this school is truly a model of equity?**

   (*Physical Environment*)

2. As we continue our tour of the building, we meet two students who talk excitedly about a class they are taking. You ask them to describe it to you. As they talk you think that this is an excellent way to help students understand about the negative effects of stereotyping. **Describe this class that gives students an experience of being equitable.**

   (*Curriculum*)

3. You ask if you could attend the class with them. The students say yes and get the teacher's permission. **What do you notice about who is in the class?**

   (*Student Assignment*)

4. You are now scheduled to attend a staff meeting. As you enter the meeting room you are introduced to the staff and you can see that the staff is also a model of equity. **What is the staff like?**

   (*Role Models*)

5. The staff meeting ends on time and we are once again in the halls heading for the lunch room. On our way we stop to visit a classroom that is having a visitor. **Who is the visitor? Why is this person here? What is the topic being discussed?**

   (*Role Models*)

Source: Reprinted with permission of The NETWORK, Inc. from "The Equitable School Walk." ©1992.

THE EQUITABLE SCHOOL WALK (continued)

6. You are in the lunch line waiting to make your salad (this school is also conscious of nutrition) and you hear a boy making derogatory sexist remarks to a girl nearby. If you are in a junior high or high school this remark is overtly sexual in nature. There are other students and teachers who overhear the incident. You are curious about how this situation is going to be handled. You are surprised. **Describe what happens.**

   (*Behavior Management*)

7. Over lunch you have the opportunity to listen to a group of students who are excited by an extracurricular event that they are participating in. You ask them about it and discover that all the students seem to be involved in some type of extracurricular or cocurricular activities. **What are some of the extracurricular or cocurricular activities that this model of equity has available for its students?**

   (*Extracurricular and Cocurricular Offerings*)

8. After lunch you have an appointment with a guidance counselor. During the interview, a student comes in who is quite agitated and asks if the counselor could see him right away. The counselor, with the student's permission, asks you to sit in. This is apparently the second time that this student has come to see this counselor to complain about racist attitudes of a teacher he has. He has tried step one which was talking to the teacher. **How is this situation handled?**

   (*Student Support*)

9. Another student has come to talk about her situation and again you have an opportunity to listen in. She is an Hispanic student who wishes to drop out of math. She says, "Please get me out of this class, I just can't do the work. Please get me into something easier." **What happens here?**

   (*Student Support*)

THE EQUITABLE SCHOOL WALK (continued)

10. At the end of the school day you meet with the administrative team. They show you the school handbook for students and staff and discuss what efforts they have undertaken and supported to help this school become a model of equity. What do you notice about the make-up of the administrative team? What are some of the administrative efforts that have helped this school to become a model of equity?

    (*Administrative Oversight*)

11. You have completed your day at a model of an equitable school and have returned to your hotel room. As you relax, you pick up the local newspaper that the hotel has kindly put in your room. As you leaf through you notice some articles about the school you have just visited. **What is in the newspaper?**

    (*any component is possible here*)

THE EQUITY JIGSAW FOCUS QUESTIONS

Members of your group have read an article relating to the equitable classroom. Please discuss the following questions as a group and be prepared to offer two or three suggestions to address each of the problems outlined below. Elect a recorder.

Problem 1. **Attitudes**: Minority students have positive attitudes towards science and mathematics in the early grades. How do we insure that these positive attitudes continue?

Problem 2. **Persistence**: Those who are most successful in science and mathematics have developed the ability to persist. Having the ability to persist in the face of conflict is essentially related to a positive self-concept. How do we help to encourage that quality?

Problem 3. **Stereotyping**: Many teachers, majority and minority, as well as many minority students, tend to stereotype science and mathematics as Euro-centric male domains. How do we eliminate that bias?

Problem 4. **Utility**: Students often do not understand how the study of science and mathematics is applicable to everyday life and valuable to further schooling and jobs. How do we help students increase their perception of the usefulness of science and mathematics?

Problem 5. **Influence of Significant Others**: Teacher, counselors, parents, and peers have a role in shaping students' attitudes towards science and mathematics. What do we do to encourage minority students and girls to see science and mathematics as career options?

Problem 6. **Academic Deficiencies**: Achievement test performance by minority students indicates growing competency in basic skills but weakness in understanding and application of concepts. What can we do to help students with concept attainment and higher order thinking skills?

Problem 7. **Learning Styles**: Instructional strategies frequently do not complement the learning styles of many minority students. How do we accommodate to various learning styles?

Reprinted with permission of
The NETWORK, Inc. (c) 1991.

The Equitable School Continuum

by: Raymond M. Rose, Frances A. Kolb, and Nancy Barra-Zuman

This instrument begins to answer the question *"What does an equitable school look like?"* The components of an equitable school are those elements that we can see or hear; that is, they are measurable and observable.

Components:

Physical Environment
Curriculum
Extra-Curricular and Co-Curricular offerings
Role Models
Student Assignment
Behavior Management
Student Support
Administrative Oversight

The Equitable School Continuum was developed to be used in any school. The companion instrument, the **Profile of an Equitable Classroom**, also developed by The NETWORK, Inc., describes an equitable classroom. Curriculum materials and training have been developed in all subject areas, to provide more specific assistance.

Version 3.2
Copyright 1991
The NETWORK Inc.,
Andover, MA
© 1991

The Equitable School Continuum

I. Physical Environment:

Definition: The physical environment of the school includes displays on all bulletin boards, posters, and presentations used to decorate the school. It also includes the greeting and messages that are posted on walls, and the style in which everyone is welcomed into the building. The location of classes, and general physical organization of the building are included as well.

Ideal

The school environment portrays female and male representatives of various races, cultures, and physical disabilities in both traditional and nontraditional roles and in non-stereotyped ways.

The school environment facilitates the integration of all members of the school.

The environment is welcoming to all students, parents, and others who visit the building.

The racial and ethnic groups portrayed arereflective of society beyond the immediate community.

The school environment provides displays and/or supplementary resources to correct unfair messages that students may have gotten elsewhere.

The physical environment is barrier free.

Acceptable

The school environment portrays male and female representatives of various races, cultures, and physical disabilities in both traditional and nontraditional roles.

The racial and ethnic groups portrayed are reflective of society beyond the immediate community.

The school staff make provisions to accommodate students with physical disablilities.

Unacceptable

The school environment reflects only traditional roles for race gender, national origin, or physical disabilities.

The school does not make any attempt to welcome students, parents, or visitors.

The school's presentation of any particular trade, career, or activity includes only one gender, race, and ethnic group and excludes persons with physical disabilities.

The physical environment contains barriers which imped the mobility of persons with disablilities.

The physical environment perpetuates stereotyping and/or separation by race, gender, or ethnicity.

The Equitable School Continuum

II. Curriculum:

Definition: Curriculum includes all aspects of a school's programs and activities that make up the complete program of education for the purpose of educating students.

Ideal	**Acceptable**	**Unacceptable**
Students have a variety of offerings open to them and are encouraged to explore a wide variety of traditional and nontraditional offerings. Programs and activities are designed to overcome the past effects of bias and discrimination (e.g., students are encouraged to examine what it means to be a woman, man, Asian-American, person with a physical disability in a modern world.) All offerings are open regardless of gender, race, national origin, or physical disablility. Students are aware that all offerings are available to them. All options are provided with the necessary resources to make them accessible for all students. Students are encouraged to accept and celebrate differences between people (e.g., gender, color, ethnicity, primary language, physical disablity, etc.).	Students have a variety of offerings open to them. All offerings are open regardless of gender, race, national origin, or physical disability. All options are provided with the necessary resources to make them accessible to all students. Those offerings viewed as traditionally female or minority get resources comparable to those offerings traditionally viewed as male or majority.	Student offerings are restricted by gender, race, or national origin. Those offerings viewed as traditionally female or minority get fewer resources. There is little or no attempt to review offerings to assess if the needs of all students are being met. Student competition between different groups of students (e.g., gender, race, ethnicity) is encouraged or condoned. Courses tend to perpetuate a limited, western, white monocultural view of the world.

The Equitable School Continuum

III. Extra-Curricular, and Co-curricular Offerings:

Definition: Extra-Curricular and Co-curricular offerings are all those activities that the school offers or provides for students which are outside the standard curriculum . Included here would be clubs, field-trips, sports, student organizations, student publications, and assemblies.

Ideal	Acceptable	Unacceptable
Students have a variety of offerings open to them and are encouraged to explore a wide variety of traditional and nontraditional offerings.	Students have a variety of offerings open to them and are encouraged to explore a wide variety of traditional and non-traditional offerings.	Students have a limited number of offerings open to them and are not encouraged to avail themselves of any offerings.
All offerings are open regardless of gender, race, national origin, or handicapping conditions. Students are aware that all offerings are available to them.	All offerings are open regardless of gender, race, national origin, or physical disability. Students are aware that all offerings are available to them.	Offerings are restricted to, or denied access to, particular students on the basis of gender, race, national origin, or physical disability.
All options are provided with the necessary resources to make them accessible for all students. Those offerings viewed as traditionally female or minority get resources comparable to those offerings traditionally viewed as male or majority.	The school surveys students to determine interest in specific activities and responds to student input to insure that the offerings are available to match student requests.	Offerings are made without regard for student interest.
All activities in some way reinforce the importance of recognizing diversity, and that all all students can contribute in all areas without regard to gender, race, ethnicity, physical disability, or language.		
The school actively solicits student input in an ongoing way to insure that the offerings are available to match the greatest variety of student needs.		

The Equitable School Continuum

IV. Role Models:

Definition: Role models are those adults in the building who provide, through their personal and professional behavior information about being a responsible person. Role models include all staff, guests in the building, and in some cases, older students who interact with younger students.

Ideal	Acceptable	Unacceptable
Students see a wide variety of role models, both traditional and nontraditional for gender, racial, or ethnic groups. Handicapped role models are present. All of these role models are given equal values and support. It is school policy to provide this diversity of role models. Students are expected to recognize that roles and careers are open to all regardless of gender, race, national origin, or physical disability.	Students see a variety of role models, both traditional and nontraditional for gender, racial or ethnic groups. Physically disabled role models are present. All of these role models are given equal value and support.	Students see a limited number of role models which tend to represent traditional roles of gender, racial or ethnic groups. Physically disabled role models are absent. Nontraditional role models, if present, are less supported and valued than traditional role models. The school does not believe that role models are an important aspect of student learning.

V. Student Assignment:

Definition: Student assignment refers to the distribution of students in classes, courses, or programs.

Ideal	Acceptable	Unacceptable
Students are assigned to classes in such a way as to guarantee integration by gender, race, ethnicity, and, where appropriate, physically disabled. Students are assigned to programs which encourage an exploration of activities (classes, courses, or programs) which would be considered non-traditional for their gender, race, ethnicity, or perceived physical disability. Students are recruited by those voluntary (elective) programs that do not have a proportional representation by gender, race, ethnicity, or physical disability. Students are assigned to classes to insure heterogeneous ability groupings.	Students are assigned to classes resulting in integration by gender, race ethnicity, and, where appropriate, by physiacal disability. Students are not "tracked" nor locked into any form of homogeneous ability groupings.	Students are assigned to classes resulting in separation by gender, race, ethnicity, or, where inappropriate, by physical disability. Courses are designated or implied as being exclusively for one gender, race or ethnic group. Students are "tracked". Students are assigned to classes based on homogeneous ability groupings.

The Equitable School Continuum

VI. Behavior Management

Definition: Behavior management refers to what the school definies as appropriate and inappropriate student behavior, the manner in which school policies are designed to control student behaviors, and how those policies are applied to student behaviors which are considered inappropriate.

Ideal	Acceptable	Unacceptable
Students are treated equitably for their behavior regardless of their gender, race, national origin or physical disability.	Students are treated equally for their behavior regardless of their gender , race, national origin or physical disability.	Students receive different treatment for the same behavior based on the student's gender , race, national origin and/or physical disability.
There is a written policy, stipulating and enforcing the behavioral infraction and the consequence(s) of each.	There is a written policy stipulating the behavioral infraction and its consequence.	There is no written policy stating the relationship between a behavioral infraction and its consequence.
There is a grievance procedure that is clearly written and communicated to students for them to use when they feel they have been treated inequitably.	There is a grievance procedure that is clearly written , and communicated to students for them to use when they feel they have been treated inequitably.	There is no formal grievance procedure for students to use when they believe they have been treated inequitably. If the procedure exists, the students have not been informed of its existence.
School policy states that students will not treat other students in a manner which denigrates them because of their gender, race, national origin or physical disability. The policy expressly prohibits harassment on the basis of gender, race, or ethnicity. The policy is enforced.	School policy states that students will not respond to other students in a manner which denigrates them because of their gender , race, national origin or physical disability. There is a policy expressly prohibiting sexual harassment.	The school has no policy in regard to student's use of derogatory terms in reference to gender /race/national origin and/or physical disability.
Students are informed that denigration of others has negative ramifications, both in school and society.	Students are informed that denigration of others has negative ramifications, both in school and society when incidents occur.	The school acts on behavioral problems on an individual basis without involving the whole school community.

VII. Student Support

:Definition: Student support refers to all the ways that a student receives support while attending school; such as methods of recognition by awards, publicity or public praise, and supports beyond the scope of the classroom such as guidance counseling, course selection, and special services of a remedial nature.

Ideal	Acceptable	Unacceptable
School policy and practice is to encourage students to explore both traditional and nontraditional interests, (e.g., career options) and develop abilities previously separated by gender , race, or ethnicity.	Objective criteria have been established for school supports which specifically prohibit bias or favoritism on the basis of gender , race, ethnicity or physical disability.	School supports encourage student conformity to stereotyped expectations reflecting gender , race, ethnic and physical disability inequities restricting life possibilities.
Students are supported in their non-traditional endeavors through policy and practice.	Students are given the same information about the benefits and advantages of school programs and activities.	Students are given messages about school policies, benefits and/or advantages of school activities and/or programs based on their gender , race, national origin and/or physical disability.
All students are given the same information about the benefits and advantages of school programs and activities. Students are encouraged to explore a wide variety of diverse programs.	The school does not participate in awarding scholarships or awards that are restricted by gender, race, ethnic group, religion, or physical disability.	Scholarships and awards are specifically designated for students of a specific gender, race, ethnic group, religion, or physical disability.
Scholarships and awards are made to students based on objective criteria that insures that gender, race, ethnicity, or physical disability do not restrict the opportunity for students.		
The school notifies organizations that have awards or scholarships restricted by gender, race, ethnic group, religion, or physical disability that it will not participate in the awarding of such.		

The Equitable School Continuum

Ideal	Acceptable	Unacceptable

VIII. Administrative Oversight

Definition: Administrative Oversight is the actions in which a school formally and informally examines itself for compliance or agreement with a set of legal mandates, and again the improvement, or maintenance of a truly Equitable School .

Ideal	Acceptable	Unacceptable
The school regularly examines its policies and programs, including school and classroom services and activities, to identify successful practices and to identify problems with discriminatory, improper, or underutilized services by specific groups of students. When problems are identified, corrective measures are developed and quickly put into place. The school involves all members of the school community in the self-assessment, including students and parents as well as the school staff. Self-assessment is considered a regular and, ongoing function; a part of the school's daily operation. Student offerings are reviewed to ensure that the skills necessary to enable full participation in society are provided to all students regardless of the students gender, race, national origin, or physical disability. The School incorporates into its self-assessment and reviews, criteria to ensure that there is a multicultural perspective which expands beyond the school community. The school actively seeks the involvement of students, parents, and employees in the development and use of a grievance process to insure that anyone who feels mistreated will feel that there are effective avenues to use to address their concerns.	The school regularly examines its policies, and programs, including school and classroom services and activities, to identify successful practices and to identify problems with discriminatory, improper, or underutilized services by specific groups of students. Corrective plans are developed and implemented to resolve identified problems. Successes which have been identified are clearly described and disseminated to the school and community. The school incorporates into its self-assessment and reviews, criteria to insure that the various cultures present in the community are represented. There are policies identified for students, parents, and employees that identify the grievance process and state that the school and district are in compliance with all civil rights legislation.	The school does not utilize a representative population of the school community to conduct any form of self-assessment. The school does not conduct any form of self-examination of existing policies, practices, and services for/or to students. The school does not conduct any form of self-assessment of its educational impact. The school will only correct problems when pressure is applied. There is no grievance procedure nor notifications of what students, employees, or parents can do when they feel that there are problems related to equity or education.

Reprinted with permission of the author and The Journal of Negro Education, Howard University. (c) 1990, 348-359.

Worldmath Curriculum: Fighting Eurocentrism in Mathematics

S. E. Anderson, *Director, Curriculum and Pedagogy Collaborative, Eugene Lang College, New School for Social Research*

A FEW GRIM STATISTICS

Before we go into the nuts and bolts (or chips and rams) of how mathematics can be taught without the racist and sexist bias of Eurocentrism, we must be clear about the sociopolitical demographic terrain in which this curricular struggle takes place. According to the Commission on Professionals in Science and Technology's report, *Scientific Manpower, 1987 and Beyond: Today's Budget—Tomorrow's Work Force* (pp. 10–17):

- by 2010—just 20 years from now—at least one-third of the 18-year-olds in the U.S. will be Black or Latino;
- by the year 2000—in 10 years—85 percent of the new members of the U.S. work force will be Blacks, Latinos, and White women—only 15 percent of the new workers will be White males;
- by 2000, 75 percent of all goods manufactured in the U.S. will be produced by automation; the fewer jobs (in absolute numbers) that will be available will either be no-skills, McDonald's-type jobs or hi-tech skills jobs;
- 619 U.S. citizens received the PhD in mathematics in 1978; however, by 1988 that number was down to 341—half those doctorates went to foreign citizens while only 3 went to Latinos, 2 to Native Americans, and one to an African American;
- in the past 11 years, only 78 African Americans received doctorates in physics and/or astronomy, along with 97 Latinos and 11 Native Americans;
- the median mathematics level of Black, Latino, and Native American high school graduates is less than sixth grade; that is, the majority of these graduates have no knowledge or only minimal knowledge of elementary algebra.

THE EUROCENTRIC BASIS OF MATHEMATICS

We can go on and on with grim statistics, but those given above are sufficient to convey the overall crisis of capitalist education. That crisis is currently on the verge of imploding precisely because of its elitist, racist, and sexist nature. As the American Association for the Advance-

Journal of Negro Education, Vol. 59, No. 3 (1990)

Copyright © 1990, Howard University

ment of Science's (AAAS) (1989) report on literacy goals for science, mathematics, and technology states:

> When demographic realities, national needs, and democratic values are taken into account, it becomes clear that the nation can no longer ignore the science education of any students. Race, language, sex, or economic circumstances must no longer be permitted to be factors in determining who does and who does not receive a good education in science, mathematics, and technology. To neglect the science education of any (as has happened too often to [White] girls and minority students) is to deprive them of a basic education, handicap them for life, and deprive the nation of talented workers and informed citizens—a loss the nation can ill afford. (pp. 156–157)

However, as Alkalimat (1990) makes clear:

> . . . strategic interests in modern society [have] structured the university as a tool of societal power to train skilled mental workers for the ever changing technical division of labor in advanced capitalism. Further, the university is used for the purpose of indoctrinating an elite with the metaphysical myth of eternal Eurocentric domination of the world. The first point is for class rule, the latter for race rule. (p. 2)

The task of progressive educators is not to try to fix or prop up the capitalist system of education. Our duty is to lay the seeds for a more egalitarian educational system based on the assumption that *any* person can learn *anything* and that we study Nature to love and appreciate its complexities, beauty, and offerings, not to control and defile it. The true beauty of mathematics comes from our ability over time to weave subjective and objective factors into a variety of logical systems that help explain the complexities of Nature. It is from this reference point that we must examine an alternative mathematics curriculum and the specific case that will be presented herein.

According to Joseph (1987, p. 22–26), the present structure of mathematics education and research—on all levels—is based on four historiographic pillars which have been placed in the sand foundation of Eurocentrism:

(1) the general disinclination to locate mathematics in a materialistic base and thus to link its development with economic, political, and cultural changes;
(2) the confinement of mathematical pursuits to an elite few who are believed to possess the requisite qualities or gifts denied the vast majority of humanity;
(3) the widespread acceptance of the view that mathematical discovery can only follow from a rigorous application of a form of deductive axiomatic logic believed to be a unique product of Greek mathematics; hence, intuitive or empirical methods are dismissed as having little mathematical relevance;
(4) the belief that the presentation of mathematical results must conform to the formal and didactic style devised by the Greeks over 2,000 years ago and that, as a corollary, the validation of new additions to mathematical knowledge can only be undertaken by a small, self-selecting coterie whose control over the acquisition and dissemination of such knowledge has a highly Eurocentric character.

Institutionalized Eurocentric curricula constantly reinforce the racial and sexual inferiority complexes among people of color and women. The dominant curriculum in use today throughout the United States is explicit in asserting that mathematics originated among men in Greece and was further developed by European men and their North American descendants. According to Ball (1922), the history of mathematics "cannot with certainty be traced back to any school or period before that of the Ionian Greeks" (p. 1). Klein, writing in 1953, claimed the following:

> Mathematics finally secured a firm grip on life in the highly cogenial soil of Greece and waxed strongly for a short period. . .with the decline of Greek civilization, the plant remained dormant for a thousand years. . .when the plant was transported to Europe proper and once more imbedded in fertile soil. (p. 10)

From generation to generation for centuries this type of Eurocentric "scholarship" has been reproduced in the objective and subjective pursuit of justifying racism and imperial rule. When there is mention in mathematics textbooks of African, Indian, Chinese, or Mayan contributions, that mention is relegated to passing sentences, paragraphs, or, on rare occasions, a non sequitur chapter.

Systematically, the vast majority of mathematics curricula in colleges and high schools are "turning off" generations of young people from pursuing careers in mathematics and science in general and, in the process, reinforcing racist assumptions about people of color (Steen, 1987, p. 251). Those of us who want to see true mathematical and scientific knowledge flourish among our youth and workers must break from the Eurocentric perspective and begin the reconstruction of the rich and complex fabric of *world* mathematical and scientific knowledge. This requires breaking with most of the pedagogical and curricular traditions that exist today. There are risks, however. If one is White and breaks with the traditions, one risks being viewed by one's more conservative racist peers as a "crackpot" liberal on a suicide mission. If one is not White, one risks being seen as some sort of atavistic militant bent on painting the ivory tower black and destroying the icons of Rigor and Proof and replacing them with Simplicity and Fun.

SIX PEDAGOGICAL DISASTERS IN MATHEMATICS EDUCATION

Before looking at my own practical experiences in teaching from a radical pedagogy, I will outline six major pedagogical disasters in mathematics teaching. Popular belief and practice dictates that before one can learn mathematics one has to:

(1) separate arithmetic from algebra;
(2) teach mathematics without any historical references;
(3) use textbooks that are elitist and cryptic;
(4) do work and be tested as an individual as opposed to working and being tested as study groups;
(5) accept the myth that mathematics is pure abstraction and, therefore, antithetical to one's cultural and working environment; and
(6) memorize, memorize, memorize . . .

Separating Arithmetic from Algebra

Because we teachers pursue pedagogy undialectically, we tend to compartmentalize knowledge rather than show the interrelatedness of it. As a result, we spend years pounding arithmetic skills into very young folk, chastising those who attempt—before we are ready to "teach" it to them—algebraic processes such as taking a bigger number from a smaller one. Additionally, most elementary and secondary school teachers just do not understand mathematics. They are akin to the one-eyed man (or woman) leading the blind as opposed to keen-sighted teachers intent on developing mathematical vision and perspective in young people. When algebra is imposed upon our youth during that dramatic pubescent period when so many other new and challenging life-altering developments are also occurring, it is retrofitted onto worn-out arithmetical computational drills. Algebra thus becomes a traumatic tearing apart—a world construct grafted onto six or seven previous years of proselytizing a limited arithmetic world disinfected from everyday experiences and the historical development of people.

By junior high school the overwhelming majority of our youth are convinced that mathematics teachers are their enemies and, even worse, that mathematics is some sort of poison or mind-control drug teachers try to force upon them. Those of us who teach mathematics at the junior high level reinforce ourselves by saying: "Oh well, mathematics is for the chosen few—the gifted—anyway." By the time most typical college freshmen enter a college mathematics class, they are filled with fear, apprehension, and misinformation about mathematics. In an accelerated scramble they run away from any mathematics or mathematics-related subjects for the rest of their college experience. Usually contributing to this scramble is the "erudite" male professor who stands arrogantly before his classes, teaching mathematics as if the students were merely *reviewing* the material—or as if there were no students before him at all!

Teaching Mathematics as an Ahistorical Development

Mathematics and the natural sciences are the only areas of study presented with little or no historical, cultural, or political references. This ahistorical approach is essential for what Alkalimat (1990) identifies as a process of "indoctrinating an elite with the metaphysical myth of eternal Eurocentric domination of the world" (p. 2). This pedagogical approach reinforces the institutionalization of Eurocentrism, class elitism, and sexism. European names such as Pythagoras, Euclid, Cauchy-Rieman, Fourier, and Newton are tossed about *sans* flesh, bones, and personalities; then they are attached to various levels of abstractions as if they always existed.

Elitist and Cryptic Textbooks

We have all had at least one experience with a mathematics text so botched, convoluted, and elitist in its explanation of concepts covered in class that we dreaded opening it. Cryptic mathematics texts are the norm at all levels of American education. Capitalist/racist education not only mass-produces these intimidating, incomprehensible mathematics texts but it also demands usage of them. Such texts ensure the class rule that Alkalimat describes. In other words, every aspect of the educational process and every facet of industrial and technological activity must convince the majority of people—especially people of color—that they are biologically, intellectually, and/or psychologically incapable of understanding mathematics.

The Individual Uber Alles

The typical secondary school or college mathematics class is structured such that individuals must compete ruthlessly with each other for "knowledge." At the beginning of most courses, the teacher, who assumes that most students will fail this most rigorous and demanding of subjects, usually lays out the *failure* parameters (although students usually already know those parameters from their own or other students' previous disastrous encounters with the subject and/or teacher). In such settings, cooperation among a few students evolves *not* as a result of its organic development in the course, the materials, or the teacher but rather out of desperation. Individualism is reinforced within the mathematics class, further strengthening and legitimizing class, race, and sexual divisions within it and within society at large. Although the student-as-loner syndrome contradicts the way most people historically and presently have solved problems, it reaffirms the foundations of capitalism's totalitarian rule.

"It's Not Real Math Unless it's Abstract"

Systematically, from kindergarten to college, from private schools to public schools, and from coast to coast, mathematics is presented as an abstraction with little or no relationship to the real world; as divorced from subjectivity; as pure, blindingly white, and, therefore, beautiful in its sinosoidal-like monotony. Only a chosen few are given the "keys" to enter this secret society of purity and beauty. Those few are selected on the basis of their class/race position and by sheer probability (because all those privileged to access mathematics will not pursue it).

Erudition, abstraction, and compartmentalization—the cornerstones of Eurocentric mathematics and science—are the products of capitalism's need to further subdivide the world, its people, and their activities (i.e., to alienate and distance people from their creative source and their creativity). This process allows capitalism to extract more surplus value from human labor and gain more control over the minds and sociopolitical activities of the people. (It is also one of several reasons why mathematicians, engineers, and scientists—as a group—have tended to be more politically conservative than their social science or humanities counterparts. Thus, our students suffer through years of math-as-"mythamatics," never internalizing it or seeing it as a *natural* human endeavor.

Rote Memorization is a Dead End

We are all witnesses to the disastrous reality of rote learning. How many of us have seen students who, by rote memorization alone, have taken—and passed—a series of mathematics courses, yet they lack even fundamental mathematics skills? How many times have we asked students questions just slightly removed from the subject they have memorized only to get silence and a glazed look as a response? Why?

We teachers and professors have reduced mathematics problem solving and testing to memorization of definitions, formulae, theorems, and the like. Thus, the student who can memorize the most and who has access to the most reference material and/or problem-solving technology will most likely do well. This kind of learning is solely for immediate recall; little is internalized or retained for use in learning the next level of mathematics.

AN ALTERNATIVE CURRICULUM AND PEDAGOGY

Reforms in mathematics education have not solved the inherent problems precisely because of their reformist nature. Reforms merely rearrange the same content into a "new and improved" format. However, there are a few of us in the mathematics education field who have broken with tradition and brought every aspect of teaching mathematics into question: our pedagogy, our assumptions about how and why people learn, our texts, and ourselves. Witness Bob Moses and his Algebra Project for elementary schools, in which youngsters learn algebra from their rides on the subway; Arthur Powell (1986) of Rutgers University–Newark and his Writing in Math project; and Marilyn Frankenstein of the University of Massachusetts and her concept of "radical math" (Frankenstein & Powell, 1989).[1] These and other progressive educators have suggested and *use* alternatives to the lock-step, nuts-and-bolts approach to the arithmetic-algebra-precalculus-calculus "learning" sequence that is so pervasive yet so devastating.

There are certain "radical" actions that can be taken to improve, quantitatively and qualitatively, students' knowledge and appreciation of mathematics as real, do-able, and *theirs*. What Bob Moses does at the elementary school level should be expanded upon. For example, students could be assigned to work collectively on a problem involving the study of turbulence in a tub or the chaotic state of a dripping faucet; their investigations could extend over a whole school semester or term, whereupon they would research and develop mathematical rules, definitions, and techniques to solve the problem. Short of a major overhaul of the first two years of college mathematics, college-level courses should be developed that show the interconnectedness of mathematics and real-world problems. These courses should also show how people throughout history have created mathematical techniques to solve problems.

HOW AND WHAT I TEACH

The following is a discussion of what I have been doing and developing over the past 20 years with a full spectrum of college students, but principally working-class Black and Latino adults (young and old) precisely because they are the most alienated from and fearful of mathematics. Rarely are these students intellectually challenged or stimulated, but once they are, and once teachers understand that they can understand, I have found their pursuit of knowledge to be unstoppable.

---

[1] For more on Moses's and Frankenstein's work see their articles in this issue.—ED.

112

Most of my pedagogical work is aimed at psychological upliftment through emphasizing that ordinary people create mathematical ideas and "do" mathematics. In my basic mathematics courses (calculus and its prerequisites), I assume the role of confidence builder; I tell my students that they all start out with an "A," yet they must struggle to maintain it. I let them know that I assume they all have the intellectual capabilities to understand the material, and if they do not I attribute it to either my own or the textbook's failure to communicate clearly. In my view, the *quality* of mathematics knowledge is central and the quantitative aspect secondary. Therefore, although I may set out to cover six chapters in a semester, I will not kill my students to achieve it. If they complete only three or four chapters and learn those well, then I am confident that they can pick up the rest.

A Typical Algebra Class

I use the same approach and structure in my elementary, intermediate, and precalculus algebra classes that I use in my finite mathematics classes or my "Math as a Human Endeavor" classes. The first two sessions are lecture-discussions on the historical, cultural, and sociopolitical implications of mathematics. In these sessions I outline the interrelationships between the development of mathematical ideas and techniques, humanity's ongoing struggle to understand Nature, and capitalism's attempts to control and dominate Nature.

From the outset I emphasize that some of the very first mathematical/scientific thinkers and innovators were African women. Humanity originated in Africa, and women, for the most part, were the first farmers; both logic and scientific evidence support the assertion that the rudimentary development of mathematical and scientific inquiry and experimentation began with them. As women and, later, men furthered the domestication of foodstuffs, they created more leisure and thinking time for themselves; thus, a few men and women began to study Nature in its qualitative and quantitative modes. Over time, however, the domestication of foodstuffs also played a direct role in dividing the sexes, bringing forth social classes and its concomitant differences in mathematics knowledge.

My lectures include discussion of the ancients' rudimentary methods of scientific observation, inquiry, and experimentation and their complementary mathematical achievements. I show how early mathematics and science led to the building of the pyramids, the Great Wall of China, and the road to Kathmandu as well as the development of astronomy and astrology, the techniques of iron smelting and metal-plating, and surgery—thousands of years before European civilization. I also show how humankind's mathematical ideas and techniques grew out of people's need to understand Nature, to build and domesticate, and to communicate and record results from various types of social interactions.

I point out to my students that the Egyptians, Chinese, and Indians used different styles of mathematical generalizations in algebraic problem solving. Pre-Hellenic algebraic proofs such as those found in two of the most important Egyptian mathematical documents, the Ahmes

Papyrus (c. 1650 BC) and the Moscow Papyrus (c. 1850 BC), while not deductively axiomatic, were and still are valid proofs. As Joseph (1987) notes: "Egyptian proofs are rigorous without being symbolic, so that typical values of a variable are used and generalizations to any other value is immediate" (p. 24).

During these sessions I stress that the Egyptians created a tremendous civilization that lasted for thousands of years. I also stress that Egypt is in Africa and that the people who inhabit the land were and are Africans. I point out that Egyptian civilization produced complex technological innovations and forms of communication and engaged in an extensive interchange of goods and ideas with other people thousands of years before they helped bring forth Greek civilization. I note that at least half of the Greek language is African in origin and that the Greek cosmological and mythological constructs were founded upon Egyptian constructs, as was Greek shipbuilding, architecture, *and mathematics*. I explain that Euclid—the so-called "father" of plane geometry—spent 21 years studying and translating mathematical tracts in Egypt. Pythagoras also spent years studying philosophy and science in Egypt and possibly journeyed East to India and/or Persia where he "discovered" the so-called Pythagorean Theorem in the Indian *Sulbasutras*, a collection of mathematical documents (c. 800–500 BC). As I ask my students, how could a theorem whose proof was recorded in Babylonian documents dating 1,000 years before he was born be attributed to Pythagoras?

The intent of these first sessions is to shatter the myth that mathematics was or is a "White man's thing" and to show my students that all civilizations, though they differ and develop at different paces, have always been bound inextricably to each other. It is important that students know that Europe is not now nor was it ever the "civilizing center" of the world surrounded by wildness and chaos. To further undo this Eurocentric assumption, I then discuss the importance of the constant flow of ideas and techniques into Europe from the early Greek through the Medieval and Renaissance periods to the rise of capitalism (see Midonick, 1965). I show how certain aspects of European mathematics could not have developed had not the Europeans traded with more advanced societies. One of the most glaring examples of this is the case of the 150-year political struggle around the incorporation of the Hindu–Arabic numeral system into common usage in Europe. For a century-and-a-half during the medieval period (specifically around 1200–1350 AD), the dominant Roman Catholic Church's fear of a rising rival class, coupled with European racism and xenophobia, impeded the spread of mathematical knowledge throughout Europe. The Vatican denounced Hindu–Arabic numerals as "the work of the devil" because it viewed the widespread use of an easy way to calculate as a means by which European merchants and craftsmen would become even more independent of the Church.

This example leads into a discussion of the myth of the "Dark Ages," which asserts that because a general retrogression occurred among the European feudal elite during the Medieval period, nothing was happening intellectually anywhere else in the world. On the contrary, ideas in mathematics, science, and philosophy flourished both inside and outside of Europe during that time. Great African and Middle Eastern Arab scholars lived and studied in places like Toledo and Cordoba in Spain as well as in Sicily. Timbuktu, Cairo, Baghdad, and Jundishapur were also key centers of scholarly learning and research. The rich and complex Arab culture that dominated southern Europe, most of Africa, the Middle East, and parts of India and China during this period brought forth such intellectual centers as Caliph al-Mansur's House of Wisdom (Bait al-Hikma) in Baghdad, where documents, scholars, and researchers integrated the great astronomical studies of Indian, Chinese, Greek, and Babylonian scholars.

Bait al-Hikma was also a research university out of which a key mathematician evolved: Mohammed ibn-Musa al-Khwarizmi (c. 825–?? AD). My classroom presentations include discussion of al-Khwarizmi because he authored two foundational mathematics texts: The first, *Hisab al-djabr wa-al Muqabala (The Science of Equations* or *The Science of Reduction and Cancellation)* not only gave Europe its first systematic approach to algebra but was also the source of the name for the subject matter (*al-djabr* or "algebra"). His second book (now found only in the Latin original), *Algorithmi de Numero Indorum*, explains the Indian numeral system. Although al-Khwarizmi emphasized the Indian origins of the numeral system, subsequent European translations of this book attributed the system to him; hence, schemes using these numerals came to be known as "algorithms" (a corruption of the name "al-Khwarizmi"), and the numerals became known as "Arabic numerals" (Joseph, 1987, p. 21).

I also mention other important Arab mathematicians such as the algebraist Omar Khayyam (c. 1050–1122 AD), known in the West solely as a hedonist poet; and Nasir Eddin al-Tusi (1201–1274 AD). It took 500 years for al-Tusi's ideas of geometry on a non-flat surface to catch on in Europe; in the eighteenth century, the Italian geometrist Saccheri used al-Tusi's work to create the basis of what we now call non-Euclidian geometry.

I then proceed to give my students an idea of the intimacy of mathematical abstraction or concepts to sociopolitical developments. I discuss the period from the eighth through the fifteenth century, when Europe, Africa, Asia, and the Americas engaged in a rich interchange of ideas and culture. I show how this interchange helped to nurture the intellectual and scientific demands of the rising European merchant class. For example, in the 1600s European merchants began making great demands on shipbuilders for more and bigger ships to carry more African slaves, raw materials, and finished products at a faster pace. Ironically, in their research to improve techniques for building very large ships, European shipbuilders turned to the wisdom of Gambian (West African), Chinese, and Indian mariners. Thus, my students come to understand the contradictions inherent in the way developments in hydrodynamics (and its attendant mathematics) contributed to the European bourgeoisie's relentless pursuit of profit and to the horror of the original Holocaust—the slave trade.

I further point out that calculus was created to facilitate the study of ballistics and the wars of land consolidation waged by England and Germany. I also show how the needs of the military in contemporary capitalist societies for more efficient weaponry and defense mechanisms have inspired and continue to inspire many mathematicians and scientists to pursue the War Machine—bringing forth new mathematical and scientific discoveries and techniques primarily for the sake of capital.

In sum, these lecture/discussions help students to understand the following:

- People of color were the original founders and innovators of mathematics and science.
- Europe was never isolated from Third World (actually First World) mathematical and scientific achievements.
- European capitalism developed because of Europe's incorporation of the mathematical and scientific ideas and techniques of the First World into their capitalist superstructure.
- Europe dominated, enslaved, and colonized Africa, Asia, and the Americas and thereby stopped and/or reversed most, but not all, forms of First World intellectual, mathematical, scientific, and technological activity.

Through this brief historical survey, I attempt to put mathematics within a human context. Although I limit term papers to my calculus and Math as a Human Endeavor classes, many of my students become very interested in the historical development of mathematics. Often they wind up doing more reading and writing term papers in the field of mathematics and science history for other classes.

A Few Words on Structuring Classes

About two weeks into a class, I facilitate the creation of study groups of no more than three or four people of the students' choice. These groups allow collective study (a concept that often must be explained to most students) and in-class group work. The study groups are responsible for one or two "progress reports" (others may call them "tests" or "exams," but I prefer my term because I want to convey the message that I am optimistic about my students' performance and concerned primarily with building mathematical confidence).

I want my students to see, talk, and read about *real* people doing *real* mathematics and getting *real* results. Therefore, I also incorporate a weekly 15- to 20-minute class discussion of the "Science Times" section of the *New York Times* to stress the direct and indirect relationship of mathematics to the social and natural sciences, the development of technology, and job market skills. These readings/discussions help "demystify" science and mathematics while they also help build students' technical and formal vocabularies.

Students are requested to note all important mathematical definitions, theorems, and formulae on note cards. They are to bring these note cards to class with them at all times, including progress report time, for use as references. However, from the very beginning I let my students know that my classes (and mathematics itself) are not about seeing who is best at memorizing; rather, they are about getting everyone to understand and use mathematics. Just as we have references available at our jobs or in our community work, we should have them when we are pursuing the solution to mathematical and scientific problems.

I encourage the use of scientific calculators in my classes. If time and computers are available, I encourage students to use some of the effective interactive software available. Nonetheless, I see the computer as a supplement, never as an alternative, to my direct interactions with students.

CONCLUSION

Primarily, the results of my two decades of evolving a non-Eurocentric approach to teaching mathematics are reflected in my students having a more positive, self-assured attitude about themselves successfully doing mathematics. For example, of the hundreds of students that took my algebra classes at the State University of New York–Old Westbury (1971–1977) and Rutgers University in Newark (1986–1989), 85 percent passed the course. Out of these about 60 percent pursued at least one more mathematics course that they initially had planned to avoid. Over that 10-year period many more African American students began taking and passing the precalculus courses at both these sites—an increase of 25 to 28 percent at Old Westbury and a 19 to 21 percent increase at Rutgers–Newark. Conversely, among students enrolled in the traditional algebra lecture and testing formats at Old Westbury, dropout and failure rates increased from 1978 to 1988. In basic algebra classes at Rutgers–Newark, the failure and dropout rates have hovered at around 50 percent for the past 17 years!

In terms of generating mathematics majors, my successes have been small ones: to my knowledge, only seven or eight of my students have decided to pursue or have successfully majored in mathematics. Thus, it can be said that this particular non-Eurocentric approach produces the basic self-confidence students of color need to get through mathematics classes and satisfy the requirements of non-mathematics majors. To generate more mathematics majors, one needs control of the entire mathematics curriculum and faculty, not just a few classes.

In struggling against a Eurocentric curriculum in any discipline, we teachers cannot rectify the problem by trying to use the same methods that have suppressed or distorted knowledge. Nor can we merely graft discussions of the particular attributes and achievements of people of color, willy-nilly, onto the existing order; to do so would only compound the madness of class-, race-, and/or gender-based prejudice. As the Egyptian political economist Amin (1989) claims, such narrow-minded nationalism can and does generate individualism:

> In every case . . . nationalist culturalist retreat proceeds from the same method, the method of Eurocentrism: the affirmation of irreducible "unique traits" that determine the course of history, or more exactly, the course of individual, incommensurable histories. (p. 77)

Those of us who are genuinely concerned with educating students for liberation rather than training them for the job market must attack, critique, and dismantle the Eurocentric educational construct while simultaneously planting the seeds for more holistic, in-tune-with-nature, popular, and egalitarian forms of learning. We cannot wait any longer. The grim statistics I mentioned at the beginning of this article indicate

BEST C

that a subtle but effective form of educational genocide is taking place in addition to the general moral and political decline of one of the greatest working classes in the world. The vast majority of us—African Americans and Latinos—presently in the halls of academe are here because of popular movements to open the universities to all. As a consequence, we are honor-bound to struggle against the tendency toward tunnel vision. In all fields of human endeavor, and particularly in the crucial fields of mathematics and science, to offer an alternative that is genuinely egalitarian and truthful we must open our eyes to the centrality of the contributions made by the vast majority of the world's people.

REFERENCES

Alkalimat, Abdul (1990). *Eurocentricism: A review of Samir Amin's Eurocentrism.* Unpublished review, Department of Africana Studies, SUNY–Stony Brook.

American Association for the Advancement of Science (1989). *Science for all Americans: A project 2061 report on literacy goals in science, mathematics, and technology.* Washington, D.C.: American Association for the Advancement of Science.

Amin, Samir (1989). *Eurocentrism.* New York: Monthly Review Press.

Ball, W. W. R. (1922). *History of Mathematics.* London: Macmillan & Co.

Commission on Professionals in Science and Technology (1986, October 15). *Scientific manpower, 1987 and beyond: Today's budget—Tomorrow's workforce.* Proceedings of a symposium, Commission on Professionals in Science and Technology, Washington, D.C.

Frankenstein, Marilyn & Powell, Arthur (1989). Mathematics education and society: Empowering non-traditional students. In Christine Keitel (Ed.), *Mathematics, education and society* (pp. 157–159). Paris: UNESCO Science and Technology Education.

Joseph, George Ghevarughese (1987). Foundations of Eurocentrism in mathematics. *Race and Class, 27*(3), 13–28.

Klein, Morris (1953). *Mathematics in western culture.* New York: Macmillan.

Matthews, Catherine M. (1990). Science, engineering, and mathematics precollege and college education. *Congressional Research Service,* IB 88068, 5–6.

Midonick, Henrietta O. (1965). *The Treasury of mathematics.* New York: Philosophical Library.

National Research Council (1989). *Everybody counts: A report to the nation on the future of mathematics education.* Washington, D.C.: National Academy Press.

Powell, A. B. (1986). Working with "underprepared" mathematics students. In M. Driscoll & J. Confrey (Eds.), *Teaching mathematics: Strategies that work* (pp. 181–92). Portsmouth, NH: Heinemann.

Steen, Lynn Arthur (1987, July 17). Mathematics education: A predictor of scientific competitiveness. *Science,* 251.

PY AVAILABLE

Duplicated with permission from
Educational Leadership May 1994.
(c) by ASCD, 4-8.

Transforming the Mainstream Curriculum

James A. Banks

Teaching from a range of perspectives will prepare students from diverse groups to work together in a truly unified nation.

Schools today are rich in student diversity. A growing number of American classrooms and schools contain a complex mix of races, cultures, languages, and religious affiliations.

Two other sources of diversity are becoming increasingly prominent as well. The widening gap between rich and poor students is creating more social class diversity, and an increasing number of gay students and teachers are publicly proclaiming their sexual orientations.

Toward an Authentic *Unum*

The increasing recognition of diversity within American society poses a significant challenge: how to create a cohesive and democratic society while at the same time allowing citizens to maintain their ethnic, cultural, socioeconomic, and primordial identities.

Our ideal as a nation has been and continues to be *e pluribus unum*—out of many, one. In the past, Americans have tried to reach this goal by eradicating diversity and forcing all citizens into a white Anglo-Saxon Protestant culture (Higham 1972).

This coerced assimilation does not work very well. An imposed *unum* is not authentic, is not perceived as legitimate by nonmainstream populations, does not have moral authority, and is inconsistent with democratic ideals. To create an authentic, democratic *unum* with moral authority and perceived legitimacy, the *pluribus* (diverse peoples) must negotiate and share power.

Even with its shortcomings, the United States has done better in this regard than most nations. Still, citizen expectations for a just *unum* are far outpacing the nation's progress toward its ideal. Many citizens of color, people with low incomes, or speakers of languages other than English feel alienated, left out, abandoned, and forgotten.

Our society has a lot to gain by restructuring institutions in ways that incorporate all citizens. People who now feel disenfranchised will become more effective and productive citizens, and new perspectives will be added to the nation's mainstream institutions. The institutions themselves will then be transformed and enriched.

In the past two decades, multicultural education has emerged as a vehicle for including diverse groups and transforming the nation's educational institutions (Banks 1994a, Banks and Banks 1992). Multicultural education tries to create equal educational opportunities for all students by ensuring that the total school environment reflects the diversity of groups in classrooms, schools, and the society as a whole.

Considering the Dimensions of Multicultural Education

The following five dimensions of multicultural education can help educators implement and assess programs that respond to student diversity (Banks 1993, 1994b).

1. The first dimension, *content integration*, deals with the extent to which teachers illuminate key points of instruction with content reflecting diversity. Typically, teachers integrate such content into curriculum in several different ways (Banks 1991b). One common approach is the recognition of contributions—that is, teachers work into the curriculum various isolated facts about heroes from diverse groups. Otherwise, lesson

© Jose Aker/FPG [illegible]

plans and units are unchanged. With the additive approach, on the other hand, the curriculum remains unchanged, but teachers add special units on topics like the Women's Rights Movement, African Americans in the West, and Famous Americans with Disabilities. While an improvement over the passing mention of contributions, the additive approach still relegates groups like women, African Americans, and disabled people to the periphery of the curriculum.

Multicultural education has emerged as a vehicle for including diverse groups and transforming the nation's educational institutions.

2. A second dimension of multicultural education is *knowledge construction,* or the extent to which teachers help students understand how perspectives of people within a discipline influence the conclusions reached within that discipline. This dimension is also concerned with whether students learn to form knowledge for themselves.

3. The *prejudice reduction* dimension has to do with efforts to help students to develop positive attitudes about different groups. Research has revealed a need for this kind of education and the efficacy of it. For example, researchers have shown that while children enter school with many negative attitudes and misconceptions about different racial and ethnic groups (Phinney and Rotheram 1987), education can help students develop more positive intergroup attitudes, provided that certain conditions exist. Two such conditions are instructional materials with positive images of diverse groups and the use of such materials in consistent and sustained ways (Banks 1991a).

4. The *equitable pedagogy* dimension concerns ways to modify teaching so as to facilitate academic achievement among students from diverse groups. Research indicates, for example, that the academic achievement of African-American and Mexican-American students improves when teachers use cooperative (rather than competitive) teaching activities and strategies (Aronson and Gonzalez 1988).

5. The *empowering school culture and social structure* dimension concerns the extent to which a school's culture and organization ensure educational equality and cultural empowerment for students from diverse groups. Some of the variables considered are grouping practices, social climate, assessment practices, participation in extracurricular activities, and staff expectations and responses to diversity.

© J. Zimmerman/FPG International

Knowledge Construction and Transformation

I would like to suggest an alternative to the contributions and additive approaches that are used in the content integration dimension. This alternative, the *transformation approach*, changes the structure, assumptions, and perspectives of the curriculum so that subject matter is viewed from the perspectives and experiences of a range of groups. The transformation approach changes instructional materials, teaching techniques, and student learning.

This approach can be used to teach about our differences as well as our similarities. Teachers can help students understand that, while Americans have a variety of viewpoints, we share many cultural traditions, values, and political ideals that cement us together as a nation.

The transformation approach has several advantages. It brings content about currently marginalized groups to the center of the curriculum. It helps students understand that how people construct knowledge depends on their experiences, values, and perspectives. It helps students learn to construct knowledge themselves. And it helps students grasp the complex group interactions that have produced the American culture and civilization.

Reinterpreting the Montgomery Bus Boycott

The history of the Montgomery (Alabama) bus boycott, which began on December 5, 1955, can be used to illustrate how the transformation approach works. Viewing this event from different perspectives shows how historians construct interpretations, how central figures can be omitted from historical records, how history can be rewritten, and how students can create their own interpretations.

Textbook accounts of the Montgomery bus boycott generally conclude that: (1) when a bus driver asked Rosa Parks to give up her seat to a white person, she refused because she was tired from working hard all day, and (2) the arrest of Rosa Parks triggered the planning and execution of the boycott.

Two important accounts by women who played key roles in the boycott contradict important aspects of the textbook conclusions. The two memoirs are those of Rosa Parks (with Haskins 1992) and Jo Ann Gibson Robinson (Garrow 1987). Robinson was an Alabama State College English professor and president of the Women's Political Council.

Students can compare mainstream accounts of the events (such as those in textbooks) with transformative accounts (such as those by Robinson and Parks). This activity presents an excellent opportunity both to learn content about diverse groups and to gain insights about the construction of knowledge.

According to Robinson, professional African-American women in Montgomery founded the Women's Political Council in 1946 to provide leadership, support, and improvement in the black community and to work for voting rights for African Americans. Many council members were Alabama State College professors. Others were black public school teachers.

In 1953, the council received more than 30 complaints concerning bus driver offenses against African Americans. For instance, black people (even when seated in the "Negro" section of the bus) were asked to give up their seats to whites. Further, blacks often had to pay their fares in the front of the

The transformation approach brings content about currently marginalized groups to the center of the curriculum.

bus, exit, and reenter through the back door—and sometimes when they stepped off the bus, the driver left them.

Robinson and other council members worked with city leaders to improve the treatment of black bus riders, but to no avail. African Americans continued to experience intimidating, demeaning, and hostile encounters with bus drivers.

As the negative pattern of incidents persisted, the council concluded that only a boycott against the bus system would end the abuse of black bus riders and bus segregation. A boycott was thought to have good potential for success because about 70 percent of Montgomery's bus riders were African American. The council planned the boycott and then waited for the right time to launch it.

The year 1955 presented three choices for the "right time." On March 2, 1955, Claudette Colvin, a 15-year-old high school student seated in the "Negro" section of a bus, was arrested after refusing to give up her seat to a white rider. Next, Robinson said:

> They dragged her, kicking and screaming hysterically, off the bus. Still half-dragging, half-pushing, they forced her into a patrol car that had been summoned, put handcuffs on her wrists so she would do no physical harm to the arresting police, and drove her to jail. There she was charged with misconduct, resisting arrest, and violating the city segregation laws (Garrow 1987).

Claudette Colvin was later found guilty and released on probation. The conviction enraged the African-American community. Six months after the Colvin incident, Mary Louise Smith, 18, was arrested on a similar charge. Smith was fined.

Then, on December 1, Rosa Parks was arrested for refusing to give up her seat. She gives quite a different reason for her intransigence than has commonly been reported:

> People always say that I didn't give up my seat because I was tired, but that isn't true. I was not tired physically, or no more tired than I usually was at the end of a working day. I was not old, although some people have an image of me being old then. I was 42. No, the only tired I was, was tired of giving in.
>
> The driver of the bus saw me still sitting there, and he asked was I going to stand up. I said, "No." He said, "Well, I'm going to have you arrested." Then I said, "You may do that." These were the only words we said to each other.
>
> ... People have asked me if it occurred to me that I could be the test case the NAACP had been looking for. I did not think about that at all. In fact if I had let myself think too deeply about what might happen to me, I might have gotten off the bus. But I chose to remain.

Fed up with mistreatment, the African-American women of Montgomery, led by their council, called for a boycott of city buses. Robinson described the preparations for the boycott:

> I sat down and quickly drafted a message and then called a good friend and colleague, John Cannon, chairman of the business department of the college, who had access to the college's mimeograph equipment. When I told him that the WPC was staging a boycott and needed to run off the notices, he told me that he too had suffered embarrassment on the city buses. Like myself, he had been hurt and angry. He said that he would happily assist me.
>
> Along with two of my most trusted students, we quickly agreed to meet almost immediately, in the middle of the night, at the college's duplicating room. We were able to get three messages to a page, greatly reducing the number of pages that had to be mimeographed in order to produce the tens of thousands of leaflets we knew would be needed. By 4 a.m. on Friday, the sheets had been duplicated, cut in thirds, and bundled (Garrow 1987).

Part of Robinson's leaflets read:

> Another Negro woman has been arrested and thrown in jail because she refused to get up out of her seat on the bus for a white person to sit down.... This has to be stopped. Negroes have rights, too, for if Negroes did not ride the buses, they could not operate. Three-fourths of the riders are Negroes, yet we are arrested, or have to stand over empty seats. If we do not do something to stop the arrests, they will continue. The next time it may be you, your daughter, or mother. This woman's case will come up on Monday. We are, therefore, asking every Negro to stay off the buses Monday in protest of the arrest and trial. Don't ride the buses to work, to town, to school, or anywhere else on Monday (Garrow 1987).

Reinterpreting the Past

Robinson's and Parks' accounts of the Montgomery bus boycott reveal that significant players in historical events can be virtually ignored in written history. For instance, most textbook accounts of the Montgomery bus boycott emphasize the work of men (like Martin Luther King Jr. and Ralph D. Abernathy) or organizations headed by men. The work of women like Robinson and her female colleagues in the Women's Political Council simply cannot be found in most textbooks.

Further, Rosa Parks' stated reason for refusing to give up her seat helps students understand that recorded history can be wrong. Students can also see that when people who have been excluded from the construction of historical knowledge begin to play active roles in interpreting history, the resulting accounts can be strikingly different and much more accurate. As Robert Merton (1972) observed, insiders and outsiders often have different perspectives on the same events, and both perspectives are needed to give the total picture of social and historical reality.

Rosa Parks' stated reason for refusing to give up her seat helps students understand that recorded history can be wrong.

Incorporating New Scholarship

Since the 1970s, people of color—who have historically been outsiders and transformative scholars—have produced a prodigious amount of scholarship on multicultural education. Their thoughtful and informative works include Ronald Takaki's *A Different Mirror: A History of Multicultural America* (1993); John Hope Franklin's *The Color Line: Legacy for the Twenty-First Century* (1993); Gloria Anzaldua's *Borderlands: La Frontera* (1987); Patricia Hill Collins's *Black Feminist Thought: Knowledge, Consciousness, and the Politics of Empowerment* (1991); and Paula Gunn Allen's *The Sacred Hoop* (1986).

Because men of color have often been as silent on women's issues as white men have been (hooks [*sic*] and West 1991), a special effort should be made to include works by women (such as those by Anzaldua, Collins, and Allen). Two important new books edited by women are Carol Dubois and Vicki Ruiz's *Unequal Sisters: A Multicultural Reader in U. S. Women's History* (1990) and Darlene Clark Hine and her colleagues' *Black Women in America: A Historical Encyclopedia* (1993).

Teaching Civic Action

One of multicultural education's important goals is to help students acquire the knowledge and commitment needed to think, decide, and take personal, social, and civic action. Activism helps students apply what they have learned and develop a sense of personal and civic efficacy (Banks with Clegg 1990).

Action activities and projects should be practical, feasible, and attuned to the developmental levels of students. For instance, students in the primary grades can take action by refusing to laugh at ethnic jokes. Students in the early and middle grades can read about and make friends with people from other racial, ethnic, and cultural groups. Upper-grade students can participate in community projects that help people with special needs. Lewis (1991) has written a helpful guide that describes ways to plan and initiate social action activities and projects for students.

When content, concepts, and events are studied from many points of view, all of our students will be ready to play their roles in the life of the nation. They can help to transform the United States from what it is to what it could and should be—many groups working together to build a strong nation that celebrates its diversity. ■

References

Aronson, E., and A. Gonzalez. (1988). "Desegregation, Jigsaw, and the Mexican-American Experience." In *Eliminating Racism: Profiles in Controversy*, edited by P. A. Katz and D. A. Taylor. New York: Plenum Press.

Banks, J. A. (1991a). "Multicultural Education: Its Effects on Students' Racial and Gender Role Attitudes." In *Handbook of Research on Social Teaching and Learning*, edited by J. P. Shaver. New York: Macmillan.

Banks, J. A. (1991b). *Teaching Strategies for Ethnic Studies*. 5th ed. Boston: Allyn and Bacon.

Banks, J. A. (1993). "Multicultural Education: Historical Development, Dimensions and Practice." In *Review of Research in Education*, vol. 19, edited by L. Darling-Hammond. Washington, D. C.: American Educational Research Association.

Banks, J. A. (1994b). *Multiethnic Education: Theory and Practice*. 3rd ed. Boston: Allyn and Bacon.

Banks, J. A., with A. A. Clegg Jr. (1990). *Teaching Strategies for the Social Studies: Inquiry, Valuing, and Decision-Making*. 4th ed. New York: Longman.

Banks, J. A., and C. A. McGee Banks, eds. (1992). *Multicultural Education: Issues and Perspectives*. 2nd ed. Boston: Allyn and Bacon.

Garrow, D. J., ed. (1987). *The Montgomery Bus Boycott and the Women Who Started It: The Memoir of Jo Ann Gibson Robinson*. Knoxville: The University of Tennessee Press.

Higham, J. (1972). *Strangers in the Land: Patterns of American Nativism 1860-1925*. New York: Atheneum.

hooks, b., and West, C. (1991) *Breaking Bread: Insurgent Black Intellectual Life*. Boston: South End Press.

Lewis, B. A. (1991) *The Kid's Guide to Social Action*. Minneapolis: Free Spirit Publishing.

Merton, R. K. (1972). "Insiders and Outsiders: A Chapter in the Sociology of Knowledge." *The American Journal of Sociology* 78, 1: 9-47.

Parks, R., with J. Haskins. (1992). *Rosa Parks: My Story*. New York: Dial Books.

Phinney, J. S., and M. J. Rotheram, eds. (1987). *Children's Ethnic Socialization: Pluralism and Development*. Beverly Hills, Calif.: Sage Publications.

James A. Banks is Professor of Education and Director, Center for Multicultural Education, University of Washington, 110 Miller Hall DQ-12, Seattle, WA 98195. Banks's most recent book is *An Introduction to Multicultural Education* (Allyn and Bacon). With Cherry A. McGee Banks, he is also co-editor of *The Handbook of Research on Multicultural Education*, in press, Macmillan.

THE NEW YORK TIMES **EDUCATION** *WEDNESDAY, FEBRUARY 12, 1992*

Bias Against Girls Is Found Rife In Schools, With Lasting Damage

By SUSAN CHIRA

School is still a place of unequal opportunity, where girls face discrimination from teachers, textbooks, tests and their male classmates, according to a report being released today that examined virtually all major studies on girls and education.

Girls and boys start school roughly equal in schools and confidence, but girls trail by the end of high school, said the study. "How Schools Short-change Women: The A.A.U.W. Report," commissioned by the American Association of University Women Educational Foundation.

"This latest report presents the truth behind another myth – that boys and girls receive equal education," said Alice McKee, president of the A.A.U.W. Educational Foundation, in the report's foreword. "The wealth of statistical evidence must convince even the most skeptical that gender bias in our schools is short-changing girls and – compromising our country."

The Specifics of Bias

For the report, researchers at the Wellesley College Center for Research on Women examined more than 1,000 publications about girls and education, including hundreds of research studies. From the material, most of it from the 1980's, the researchers concluded that:

Teachers pay less attention to girls than boys.

Girls still lag in mathematics and science scores, and even those who do well in those subjects tend not to choose math and science careers.

Reports of sexual harassment of girls by their male classmates are increasing.

Some tests remain biased against girls, hurting their chances of scholarships and getting into college.

School textbooks still ignore or stereotype women, and girls learn almost nothing in school about many of their most pressing problems, like sexual abuse, discrimination, and depression.

"This is truly a wake-up call to the nation's education and policy leaders, parents, administrators and guidance counselors that unless we pay attention to girls' needs today, we will find out 15 years from now that there is still a glass ceiling," said Anne Bryant, executive director of the association. The report addressed the experiences of girls in public schools from preschool through high school.

The report does acknowledge that girls generally get better grades than boys, but argues that, when all their school experiences are examined, girls are still shortchanged. And the United States Department of Education says that 61.6 percent of the girls who graduated from high school in 1989 were enrolled in college that fall, compared with 57.6 percent of the boys.

The report makes 40 recommendations, including training teachers and changing teaching methods to meet girls' needs, encouraging girls in mathematics and science, toughening school policies against sexual harassment and placing girls' problems on the agenda of education reformers.

"This Is Dynamite Stuff"

While the individual research programs that the report synthesized have been published previously, together they paint a damning picture of girls' lives in school. The findings, many educators said, will surprise many teachers and administrators and could help them.

"I think this is dynamite stuff," said Keith Geiger, president of the National Education Association, the country's largest teachers union. He said the research "makes the point very clearly that there are many subtle and unknown things teachers do in the classroom" that hurt girls.

Both he and David Imig, executive director of the American Association of Colleges for Teacher Education, said they planned to distribute the report to their members to help teachers learn how to treat girls more fairly.

In one of the best-known studies cited in the report, Myra and David Sadker observed teachers over three years and found that most teachers called on boys more often than girls, offered boys more detailed and constructive criticism and allowed boys to shout out answers but reprimanded girls for doing so.

Although there is very little research on the experience of black girls in school, one study did find that when black girls tried to approach teachers, teachers tended to rebuff them and paid more attention to white girls.

Girls May Be Ignored

These and other examples of bias

have held girls back in math and science, the report argues. Two recent studies found that many science teachers, and some mathematics teachers, tended to ignore girls in favor of boys.

Boys not only continue to score higher than girls on science standardized tests, but the gap may be widening, the report found. Moreover, even those girls who did well in science and mathematics tended not to pursue careers in those fields. Studies of girls who continued to study science after high school showed that encouragement of teachers was crucial in their decisions.

Are girls shortchanged from preschool through graduation?

Researchers cited in the report also found that girls had less confidence in their math abilities than boys did, and that as their confidence diminished, so did their performance.

But the report also offered some good news: the gap between boys' and girls' mathematics scores is narrowing, according to a review of standardized test results. The report pointed to the success of special programs in math and science for girls in the summer or after school as one way to bolster girls' confidence and interest.

Tests Still Fall Short

Yet the report cautioned about over-relying on standardized test scores, which it found underestimated girls' performances, particularly in mathematics and science. The report found that girls' grades are far higher than their standardized test scores, and said that while many test developers have worked to eliminate obviously biased test questions, instances of bias remain. For that reason, the report said, tests should be given less weight in determining scholarships and college admissions.

Teachers who want to help girls in the classroom can draw on a range of teaching techniques that researchers have found effective. One such strategy is "cooperative learning," in which students study in groups rather than being pitted against one another. Because several studies show that girls often learn better in single-sex environments, the report also suggests creating all-girl work groups within a mixed classroom. Researchers also recommend that teachers eliminate sexist language, strive for a congenial classroom atmosphere and videotape themselves teaching to monitor their behavior toward girls.

Girls in school are also enduring increasing sexual harassment from their male classmates, but many teachers tolerate such behavior, the report said. But these and other problems central to many young girls' lives – like sexual abuse, sexism in society, sex education or depression – are rarely discussed in the classroom, the report said.

Some of these problems actually contribute to girls' dropping out of high school, the report said. Contrary to popular belief, less than half of girls drop out because they are pregnant. Many are asked to take on too many family responsibilities at home – something that more active discussion of female roles and sexism might equip women to resist, the report suggests. Those teenagers who are pregnant often find that schools discourage their return, or fail to be flexible enough to help them graduate.

In a widely-discussed study issued last year, the A.A.U.W. reported that girls' self-esteem drops markedly, even faster than that of boys, as they approach adolescence. Although the writers of this report say no research has been done to document a cause-and-effect connection, they speculate that a sexist curriculum may be one reason.

"Students sit in classrooms that, day in, day out, deliver the message that women's lives count for less than men's," the report said. Only one of 10 books most commonly assigned in high school English classes was written by a woman, and while many textbooks have added more material on women, there is still too little, the report argues. ■

Reprinted with permission
of The New York Times.
(c) 1992.

Reprinted with permission of the Mid-Atlantic
Equity Center from Mathematics and Science: Critical
Filters for the Future of Minority Students by
DeAnna Banks Beane. (c) 1988, 16-18.

Classroom Factors

• Teacher Expectations

Teacher expectations and perceptions may have a significant effect on minority student performance in both mathematics and science as evidenced by these research-based observations:

Rist (1970)—The perceptions teachers have about students are determined by social and cultural criteria, not academic criteria.

Dusek (1975)—Teachers frequently assume students to be less capable of learning if they are Black or poor. This leads to differential treatment which affects student achievement.

Jackson and Cosca (1974)—White students receive significantly more praise and encouragement than Hispanic students.

Rowe (1974)—Top-rated students are allowed more time to answer questions and participate in a differentiated verbal reward system.

Gay (1975)—Teacher's behavior toward students and the opportunities available to students are primarily based on the teachers' perceptions and expectations.

Teachers tend to treat Black and white students differently: white pupils receive more praise and other positive reinforcement than Black students.

These and other researchers have designed systems for observing and instruments for recording teacher-student interaction patterns in the classroom. Evidence is mounting to indicate that our perceptions about students influence our expectations of what they can achieve and how they will behave. These expectations can become self-fulfilling prophecies.

Positive teacher expectations improve student behavior and increase achievement. When teachers are told, for example that randomly selected students are high achievers, or that these students have been identified as "intellectual bloomers" who are expected to make high academic grades, teacher behavior varies enough to have significantly positive effects on student performance, both in the classroom and on I.Q. tests (Rosenthal and Jacobson, 1968; Good and Brophy, 1970; Bloom, 1981; Good, 1981).

Research indicates that teachers tend to see minority students as lower achievers and majority students as higher achievers even when performance is identical (Woodworth and Salzer, 1971; Antonopolis, 1972; Crowl, 1971). In one study of undergraduate student-teachers' interaction with a sample of 264 Black and white seventh- and eighth-graders, it was found that Black youngsters were given less attention, ignored more, praised less, and criticized more than their white counterparts (Rubovits and Maehr, 1973). Washington (1982), in a study of racial differences in teacher perceptions of first and fourth grade students reported that both Black and white teachers viewed Black boys as most negative and Black girls next on traits such as achievement, cooperation, adjustment and physical appearance. Regardless of gender, Black children were viewed more unfavorably than white children by both Black and white teachers. Gay (1975) hypothesized that teachers tend to react to students through their own middle class standards and perceptions. She also theorized that more pupils from racial minorities fall into the low socio-economic groups and are labeled as troublemakers and low achievers.

Mathematics and science are often perceived as higher-order disciplines and teachers often perceive minorities as low-achievers. It seems likely that mathematics and science may be perceived by many elementary teachers as a white-male domain and therefore the most positive expectations in those disciplines are reserved for white males. The model developed by Good and Brophy (1978, p.72) presents us with a helpful summary of how expectations affect student behavior:

1. The teacher expects specific behavior and achievement from particular students.

2. Because of these different expectations, the teacher behaves differently toward different students.
3. This treatment communicates to students what behavior and achievement the teacher expects from them and affects their self-concept, achievement motivation and level of aspiration.
4. If this treatment is consistent over time, and if the students do not resist or change it in some way, it will shape their achievement and behavior. High-expectation students will be led to achieve at high levels, while the achievement of low-expectation students will decline.
5. With time, students' achievement and behavior will conform more and more closely to that originally expected of them.

• Teacher Anxiety: Mathematics

Elementary mathematics instruction may be significantly affected by mathematics anxiety experienced by some teachers. The mathematical competency of the teacher is a factor that has not been well researched, particularly at the elementary and middle school levels. A logical argument can be made that teachers who are not well-trained in mathematics and especially those who have some anxiety or negative feelings about mathematics are inadequate math teachers and poor models for developing mathematical competency and interest. Some have been observed teaching only those curriculum concepts they feel comfortable with, avoiding concepts they find stressful. Math anxious teachers can pass their fears to students who have previously felt an intuitive appreciation for mathematics.

The issue of gender must be raised in any discussion of teachers, math anxiety and minority achievement. Since 87% of the teachers at the elementary school level are female and math anxiety has been prominent among females, many elementary school teachers may be providing both poor instruction and poor role models. It may be reasonably argued that while these teachers will avoid or provide ineffective instruction in areas where they do not feel competent, their higher expectations for white male students may somewhat compensate for the deficient instruction. Thus inadequate instruction may disproportionately affect the minority student, the low socio-economic student and the female student.

Pulos, Stage and Karplus (1982) conducted a study of the relationship between school setting and student mathematics reasoning skills in three similar schools with sizable minority populations. They found that student attitudes toward mathematics and performance on reasoning tasks were highest in the school with the most positive teacher attitudes toward students and mathematics instruction. In that school:

a. The teachers believed that a large percentage of their students were motivated to perform well in mathematics.
b. The teachers felt comfortable with the mathematics curriculum and freely supplemented the texts with materials which challenged students to think.
c. The teachers participated in regular in-service programs on the teaching of problem solving skills.
d. The teachers effectively applied the in-service program strategies in their classrooms.

• Teacher Anxiety: Science

Although the issue of science anxiety has not received the level of public attention given to math anxiety, Mechling and Oliver (1983) have summed up the situation bluntly. In *Handbook II* of the Project for Promoting Science Among Elementary School Principals, these authors point out that "Many teachers slough off their science teaching responsibilities. Teachers who are effective in other areas often avoid science because they lack training and have no confidence in their ability to teach it, or because they don't like science..." (p. 20). Sometimes this avoidance is excused with "I don't have time to teach science because of the pressures to get the basics taught." Later in *Handbook IV* they assert that teachers' attitudes toward science and the way it is taught most likely determine children's attitudes toward science. A teacher with science anxiety only reinforces the misperceptions of the minority child who may come from a culture in which science is perceived with distrust, and the methodology and knowledge of science are considered incomprehensible.

Thus, most of the preceding discussion of math anxiety in teachers and its impact on minority students can be appropriately applied to science instruction as well. There is one significant difference which must be kept in mind: improved mathematics instruction and achievement are integral components of the "back to basics" movement while the importance of excellent science instruction has been largely neglected in this crusade. Because of the attention paid to building basic skills in mathematics, the test scores in this area of mathematics are improving for many minority students while their performance in science skills reflects no similar substantial gains.

Elementary school teacher effectiveness in mathematics and science may be suffering from a double-edged sword: the anxiety-avoidance syndrome of teachers and the behavior pattern of teachers based upon biased perceptions and low expectations for minority students.

• Instructional Practices

The preceding discussion explored student and teacher related factors which appear to affect minority student participation and performance in mathematics and science. Examination of these factors forces us to look at the relationship between minority student achievement, instructional strategies and programs.

While there is no absolute agreement on which instructional practices have contributed most to minority student underachievement, the following list represents some of the long time practices frequently mentioned:

a) Ineffective practices common to both mathematics and science teaching

1) utilizing teaching strategies which do not consider a variety of learning style needs
2) overemphasizing drill and memorization of facts and underemphasizing understanding and application of concepts to the student's environment
3) promoting a highly competitive rather than a cooperative environment for students
4) teaching mathematics and science in isolation from each other, and in isolation from the rest of the curriculum
5) waiting an insufficient period of time (less than 3 seconds) for a student's response to a teacher's questions
6) neglecting to incorporate manipulative materials and hands-on activities as regular instructional strategies
7) utilizing textbooks, audiovisuals and other materials which communicate race bias and/or which do not represent the multicultural realities of the student's environment

b) Ineffective practices in mathematics teaching

1. teaching as though mathematics has no relationship to the child's real world; using irrelevant word problems and unfamiliar analogies and examples
2. presenting mathematics as a pencil and paper activity neglecting the tactile or kinesthetic-based learning needs of children
3. promoting the belief that mathematics is logical but not creative, and that there is one best way to do a problem
4. disregarding the need for systematic instruction in "how to solve problems"

c) Ineffective practices in science teaching

1. focusing exclusively on science content, giving little emphasis to the process of science which develops transferable thinking skills
2. teaching from the textbook or by "teacher talk" most of the time
3. providing too few hands-on experiences which facilitate student understanding of abstract science concepts
4. allotting insufficient time for science lessons
5. neglecting to promote science as a problem-solving discipline, suitable for exploring out of school conditions and natural phenomena

Reprinted with permission of the American Association of School Administrators. (c) 1991, 8-11, 14, 16-19.

IBM Corporation

The Road Less Traveled By GIRLS

Susie Fitzhugh

Educators Seek Ways To Boost Female Achievement in Math and Science

BY NATALIE CARTER HOLMES
Editor, AASA *Leadership News*

Sixth-grade teacher Pat Milefchik swears that sensitivity to sex equity in education has changed since the early 1980s, when she sat through a humiliating professional development experience in which a speaker on gender issues ended his talk with a joke using a brassiere as a visual aid.

BEST COPY AVAILABLE

Susie Fitzhugh © 1991

The progress women make in science and technology is linked to our nation's health.

lls © 1991

Evidence suggests some progress is being made.

For one, states are paying more attention to the issue by disaggregating course enrollment and achievement data by gender. For example, New York State, last year, began to disseminate school-by-school and district-by-district gender comparisons for each of its seven testing programs, as well as for attendance and course enrollments.

Other positive indicators include:

- The growing percentage of females ages 14 to 34 who have completed high school during the last 20 years and the 6 percent decline in the number high school dropouts among women ages 16 to 24 during the last 12 years;
- The average number of Carnegie units earned by girls in mathematics, science, and computer science rose

130

slightly between 1982 and 1987, according to the U.S. Department of Education;

- The 1990 mathematics report card from the National Assessment of Educational Progress showed comparable achievement of males and females at the fourth and eighth grades; and
- Increasing enrollment of girls in high school math and science courses, according to a recent 16-state study of course-taking by the Council of Chief State School Officers. In some states, the report said, boys and girls are equally enrolled in upper-level courses like physics.

Peggy Scott Hampton © 1991

Persistent Disparities

Less encouraging, though, is that males at grade 12 still outperform females in every mathematical content area, except algebra and functions, according to the NAEP report. In science, recent trend data from NAEP indicate the performance gap between the sexes has increased at age 9 and more than doubled at age 13 since 1970.

While more women than men have taken the Scholastic Aptitude Test since 1975, men continue to outperform women on the math section. In 1991, men averaged 497, women 453.

For sex equity advocates, the signs in vocational education and career preparation are no more promising.

The American College Test program indicates its test-takers still make their career choices along traditional lines, with only 3 percent of women choosing engineering as a major, compared to 19 percent of men.

One national study of vocational education last year indicated that between 1976 and 1987, female high school graduates averaged nearly one credit less of occupationally specific vocational education and one credit more of general vocational and consumer and homemaking education than male students.

The survey, conducted for Congress under the reauthorization of the Carl D. Perkins Vocational and Applied Technology Act Amendments of 1990, also found little change in the amount of sex segregation in the fields of agriculture, construction, mechanics and repairs, health, and occupational home economics, which make up 48 percent of all specific employment preparation.

Susie Fitzhugh © 1991

Meanwhile, fewer than one in three high schools even has a physics teacher. Enrollment in upper-level math and science classes remains stubbornly low in most districts, and those courses are populated largely by boys.

More importantly, experts in gender equity say, subtle practices at the school and classroom level are denying girls the opportunity to reach their full potential. According to the Council of Chief State School Officers, these less obvious indicators of achievement are not measured systematically by states or school districts.

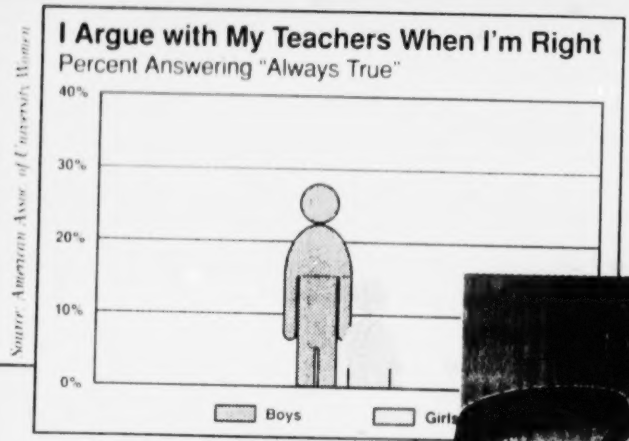
Myra Sadker, one of the nation's authorities on gender bias in the classroom, says course enrollments alone do not provide clear evidence that girls have gained access to challenging coursework.

"Some people thought course enrollments were the answer, but they're only part of it," says Sadker, director of the master's program in teaching at American University and co-author with her husband of a chapter on gender in the American Educational Research Association's "Review of Research in Education 1991."

"It's one thing to get equal access to the class. It's another thing to get equal access once you're in there," she says.

Equalizing Opportunities

Some schools are committing to more equitable treatment of girls in three areas: math, science, and com-



puter education. Girls' special needs traditionally have gone unrecognized or ignored in these fields, which can be important predictors of long-range career achievements and earning power.

In mathematics, for example, a recent U.S. Department of Education study found women in business-related occupations who took more than eight credits of college-level math earned as much or more than their male counterparts at age 32.

"There's a lesson in this," says the study's author, Clifford Adelman, a division director in the Office of Educational Research and Improvement. "Though fewer of them study it, women cannot only do math, but also do very well in math."

The lesson has implications for educational as well as economic competitiveness. One of six national education goals pledges U.S. students will be first in the world in math and science achievement by the year 2000. Clearly, the continued progress of girls will be a major determinant of how close the nation comes to meeting that target.

The other dimension has to do with prosperity of the nation as a whole. During the 1990s, 64 percent of new entrants into the work force are going to be women. The progress they make in the fields of science and

[illegible] You Can Address Gender Equity

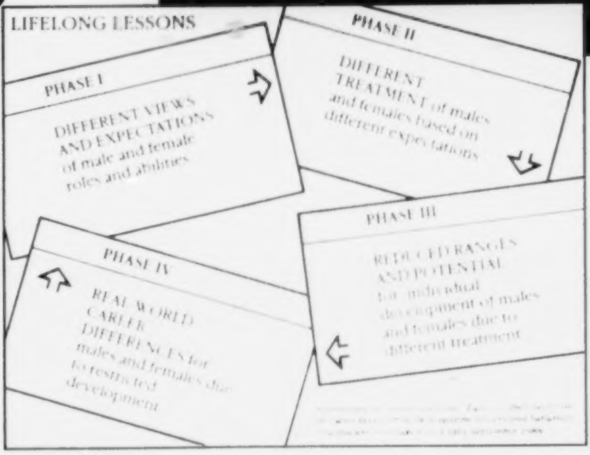
The first step in addressing gender equity issues in your school district is to acknowledge there may be a problem.

At the same time, recognize there may be a relationship between gender, racial, and national origin issues.

Then, district leaders might want to consider the following suggestions to enhance learning opportunities for girls in school and their career prospects once they graduate:

- Collect and use data on achievement and course enrollment (including course-dropping patterns) by gender, especially in math, science, and vocational programs, as well as participation in extracurricular activities to assess the current status.
- Provide staff development, both general and subject-specific, for administrators and teachers to help them grade their own performance; teach them to recognize evidence of bias in the classroom, even in its subtlest forms; and develop strategies to assure a supportive classroom climate.
- Ensure teachers are using instructional techniques that engage students, including cooperative learning, opportunities to work independently, and hands-on activities.
- Ensure that textbooks and other curriculum materials in all subjects portray women as doers, leaders, and decision-makers, rather than as helpers or victims. Integrate more supplementary books by and about women.
- Educate students and parents about work force trends and nontraditional roles for boys and girls through career awareness sessions, field experiences, and by bringing professional role models into the classroom.
- Require boys and girls to take courses that prepare them both for family responsibilities and for career achievement.
- Ensure that guidance and career counselors are up-to-date on the wide variety of career choices and paths available to men and women.
- Build partnerships with other institutions, businesses, and professional organizations that can offer new perspectives to students. For example, find out from the health department how many teens gave birth last year and then examine your own school district's performance in helping them become self-sufficient.
- Update the Title IX self-evaluation required of each school district in 1975 to address the issues of the 1990s.

Susie Fitzhugh © 1991


LIFELONG LESSONS
PHASE I
DIFFERENT VIEWS AND EXPECTATIONS of male and female roles and abilities
PHASE II
DIFFERENT TREATMENT of males and females based on different expectations
PHASE III
REDUCED RANGES AND POTENTIAL for individual development of males and females due to different treatment
PHASE IV
REAL WORLD CAREER DIFFERENCES for males and females due to restricted development

technology is inextricably linked to the health of our nation

Early Exposure

Capturing more girls' attention in the areas of math, science, and technology goes beyond mandating a certain number of credit hours. For example, some teachers and administrators are:

- Ensuring students at earlier grade levels are aware of career options in math, science and technology;
- Modifying curriculum and instructional techniques to make the subject matter more dynamic and inviting; and
- Providing female role models from government, business, and industry.

Milefchik, a math teacher at Fair Oaks Middle School in Fort Dodge, Iowa, is among a number of teachers throughout the country who have modified the traditional career day experience to focus specifically on women in career fields with a heavy emphasis on math, science, and technology.

She and a local nutritionist began a program three years ago after reading about the large number of women dropping out of the pipeline to these fields as they moved through schools and universities.

Milefchik has hosted presentations by accomplished professional women in architecture, chemical engineering, biochemistry, technical writing, dermatology, pharmacy, dentistry, law, and accounting. When she is unable to find role models in the local community, she taps into the resources of Iowa State University.

The university is attempting to attract more women to science and engineering through annual career conferences for middle school and high school girls called "Taking the Road Less Traveled."

"To get where you want to go, you have to do things in a broad-based way," stresses Mary Wibert, Iowa's state coordinator of sex equity programs under the Perkins Vocational Education Amendments. State coordinators under Perkins are required to monitor compliance with state and federal regulations. But Wibert believes local initiative, not mandates and sanctions, is the key to enticing more girls to higher achievement in math and science.

"When we go out and do site visits and we say, 'OK, let's see your plan,' a lot of [school administrators] have to stop and remember where they filed it," she says. "Any school can be in paper compliance. The bottom line is, that doesn't affect the kids ... unless it's put into practice."

Teachers should lead in developing plans for achieving gender equity, since they are closest to students, Wiberg believes. Yet school districts have a greater role to play in tracking the progress of their students beyond graduation.

Bragging of a 75 percent college-going rate among graduates is not sufficient, she says, when females are dramatically underrepresented in high-paying fields like engineering.

"That says something about our elementary and secondary education system with regard to what we say and how we encourage girls," Wiberg says.

Superintendent's Role

National experts in gender equity agree that school districts are not doing enough ongoing assessment of

continued on page 16

BEST COPY AVAILABLE

continued on page 16

girls' status in the classroom.

"Too often they have a policy and nothing else," says David Sadker, director of the master's program in elementary education at American University who is the other half of the husband-wife training and research team on gender equity with Myra Sadker.

School leaders often say, "We've dealt with that issue," says Sadker. "What they mean is, it's been dealt with politically, such as including women on a textbook selection committee."

Superintendents do have a role to play, first, in recognizing that gender equity is an important issue, and second, in empowering staff members to address inequities where found.

Charles Stoddart, superintendent in Orchard Park, N.Y., which has instituted strategies to solicit girls' interest in computers, says staff members raised concerns to him that girls were underrepresented in that area. "What we did on this end was to listen and believe that what they were saying was true," he says.

Stoddart says one barrier to effectively addressing inequities between male and female achievement and participation in school is recognizing there might be a problem. The prevailing wisdom in Orchard Park, as in many local communities, was that boys and girls, in fact, would not be represented equally across all facets of school life, he says.

"Our immediate thought was there was no sex equity problem in Orchard Park," he concedes.

"The difficulty is really in two areas," adds Blanche Fraser, superintendent of Mount Clemens, Mich., Community School District and the first female president of the Michigan Association of School Administrators. "One is making people recognize that there is a problem. The other is in translating those concerns into action."

Mount Clemens three years ago began focusing on gender equity issues as part of their larger school improvement effort using an outcome-based model.

As seems to be the case nationwide, Fraser says, girls were on equal footing with boys in their achievement and course-taking until high school, when they began to opt out of challenging courses like calculus.

"Consequently, when they took the ACT, they were less prepared," she says. "The girls at Mount Clemens came into high school pretty self-assured. But by the 12th grade, they had adopted all of the traditional attitudes and beliefs about themselves."

Using a comprehensive assessment tool offered by the state department of education, the district found an "erosion of self-esteem" among girls stemming from low expectations. "They were coddled," Fraser says. "They were given more chances."

While the school district stopped short of increasing graduation requirements, assistant high school principal Linda Petros says her school encouraged math teachers, in particular, to communicate higher expectations to students since teachers are the greatest predictor of whether a student progresses to the next level. This has contributed to gains in calculus, where enrollment today is half female, up from 20 percent three years ago.

Tackling Subtleties

The Sadkers, who have consulted widely with state departments of education, university faculty, teachers, and administrators, concentrate on eliminating subtle kinds of sex bias.

Their method of training teachers to recognize and eliminate gender bias in their classrooms introduces the subject with a video of a teacher in a typical classroom. They ask observers to assess the level of bias in the teacher's technique as well as classroom organization.

In most cases, the Sadkers say, even experienced teachers do not detect biases until they experience them firsthand in role-playing activities or are taught to recognize them with a "coding instrument"—two activities included in the Sadkers' training.

Charol Shakeshaft, chair of the department of administration and policy studies at Hofstra University, has researched gender equity and says efforts to address the needs of male and female students must go beyond general awareness of historic achievement gaps to help teachers apply the research.

"I wouldn't have thought that I gave more time to males in my classes than females," Shakeshaft says. But after assessing her practices objectively, she discovered "in fact, I gave them more time ... primarily because they demand it."

Males in her classes were more aggressive about asking questions and approaching her after class, she notes. In order to keep females similarly engaged, Shakeshaft says she began calling on students according to the order their names appear in a stack of notecards she carries.

But verbal interaction with students is only one place where teachers may need objective coaching to recognize biases in their performance.

Linda Kelley, a principal at Hopkington High School in Contocook, N.H., admits she was shocked recently to observe girls seated in the back and on the periphery of a physics class—a common scenario in all subjects, according to researchers like the Sadkers. They say this is another indicator that girls may not be fully engaged even when they are enrolled in upper-level courses.

In Merced County, Calif., career interest inventories of students told educators something was sapping girls' enthusiasm for math and science, even when they were doing well in upper-level courses.

To encourage girls with a 3.0 grade point average or above in math or science to pursue careers in these areas, the district instituted a state of California program called Making Electives Count for Career Achievement, or MECCA. Like the middle-school effort in Fort Dodge, MECCA brings role models into school and runs field trips to business, industry, and government facilities. Also, MECCA tries to whip up enthusiasm among girls at Atwater's feeder schools.

In Los Angeles, school administrators and teachers saw a projected shortage of workers in the aviation industry as an opportunity to attract girls into non-traditional occupations, with an immediate payoff. "The forecast is that in the next five years, they will not have enough people in the aviation field," says Juanita McDonald, director of gender equity for the Los Angeles Unified Schools.

Last year the district began a cooperative program with nearby North Valley Occupational Center that qualifies students in five semesters to take an aircraft mechanics licensing exam. Most graduates have been placed in jobs with entry level salaries of $30,000. This year, 65 girls from Monroe High School will participate in the program.

McDonald says the keys to attracting girls to the program are twofold. "One is to let them know there are opportunities they haven't looked at. The second thing is you have to help gear them toward an attitude that they can do this."

Aggressive Attitudes

Despite gains in course enrollments in technical areas, computer science stubbornly remains dominated by males.

Linda Cassyd, director of a sex equity commission for the Los Angeles Unified School District, says she was shocked to discover that no girls were among the 20 local students honored last year in a computing contest conducted by Rockwell International. When the commission drew attention to the lack of female representation, Rockwell agreed to publish a guide to help educators open up the world of computing to girls.

Cathy Marriott, a computer coordinator for the Orchard Park, N.Y., school district, illustrates the strong societal messages schools fight when they try to encourage girls to increase their computer literacy. She recalls a middle school girl being told by her father she was not to touch the home computer—it was for the older brother and father's use only.

"In general, the issue isn't access," says Jo Sanders, director of the Computer Equity Expert Project, a national training program for teachers and administrators funded by the National Science Foundation, IBM, and other corporations.

"The problem is, girls are declining the opportunities. Girls look around and see that boys and men use computers more than girls or women. They look at home and there's evidence that brothers and fathers use computers more than mothers and sisters. Look at the video arcade, in stores, and in the media. It's like football or car engines," Sanders says.

Even though computer education is required of all students at Orchard Park Middle School, teachers who kept records noted boys used computers during their free time much more frequently than girls. What's more, girls who did use computers often relinquished them to aggressive boys.

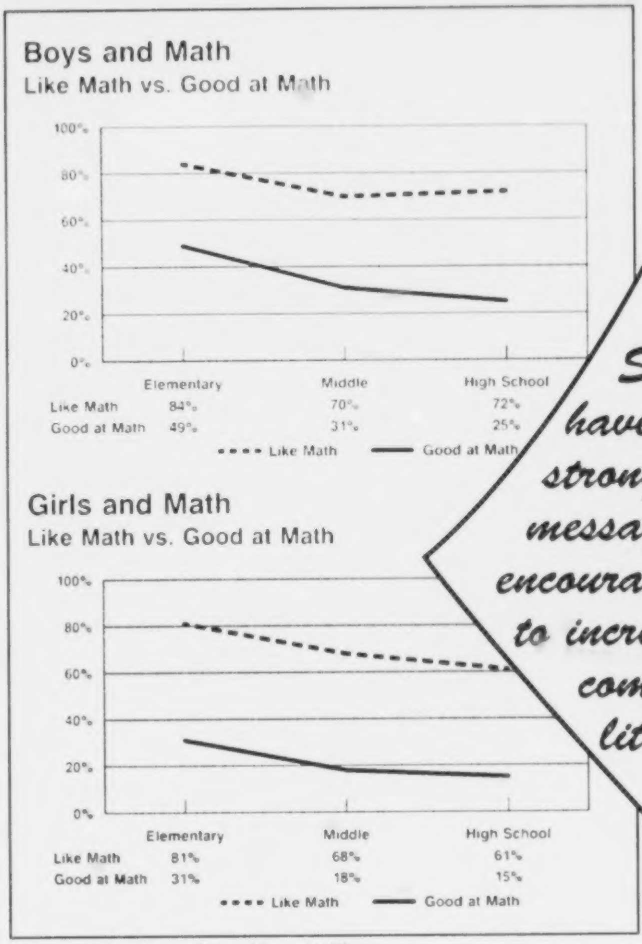
To correct this inequity, the school began in 1988 an after-school club called "Especially for Girls." Besides introducing girls to careers associated with computers, the club employs a hands-on philosophy that encourages girls to explore the applications of computers according to their interests. One popular activity uses the geography-skills game "Carmen Sandiego" to capitalize on girls' positive response to cooperative learning. Each has a clue to share in finding the perpetrator of a crime.

But response to the computer equity project was not uniformly positive. Barbara Chomura, Orchard Park's former computer coordinator who introduced the program, says some teachers initially were hostile to the mandatory half-day in-service on general issues of gender equity. The in-service reviewed research on socialization of girls, the positive impact of cooperative learning on girls, and effective teacher feedback for girls.

The underlying attitude was, "Is this really that important, given all of the other important issues we have to deal with?" Chomura says. A second day of in-service that was subject-specific for math and science teachers seemed to be better received, she says.

Stoddart, Orchard Park's superintendent, acknowledges the tendency among school leaders to view gender equity as a trivial issue, in light of more pressing business, which he identifies as "budget, layoffs, decreasing property tax revenue," and the like.

"It certainly does have a much lower priority," he says, adding one way to capture the attention of policymakers is to frame gender equity as a prominent piece of educational eq-



Source: American Association of University Women

Schools have to fight strong societal messages when encouraging girls to increase their computer literacy.

BEST COPY AVAILABLE

Disney
for our
Children

Bruce Springsteen
Debbie Gibson • James Taylor
Carole King • Sting • Little Richard
Ziggy Marley • Paul McCartney
Bette Midler • Bob Dylan • Paula Abdul
Pat Benatar • Stephen Bishop
Ann & Nancy Wilson
Harry Nilsson • Barbra Streisand
Jackson Browne & Jennifer Warnes
Elton John • Meryl Streep • Brian Wilson

TWENTY-TWO STARS WITH ONE WISH.

YOU CAN HELP MAKE IT COME TRUE.

Join with us, Walt Disney Records and these twenty-two artists to raise funds to find cures and therapies for children with AIDS. By owning this spectacular collection of children's music, you'll be sharing in a heroic effort.

All proceeds from "For Our Children" go directly to the Pediatric AIDS Foundation.

Twenty-two stars and one wish. Join us, and know that you're helping to make our wish come true.

Cassette $9.95
Compact Disc $15.95
Companion Book $16.95
Add 12% shipping and handling

We need everybody's help on this one!
Call **800-262-4347** now!
Or send your order to:
Children, P.O. Box 2113,
Santa Monica, CA 90407-2113

HELPING YOU. HELPING CHILDREN
LEE CANTER & ASSOCIATES

This advertising space was generously donated by "The School Administrator."

unity overall. That way, it becomes part of total system improvement.

National Self-Interest

Fraser, pointing to the fact she is one of 22 female superintendents among Michigan's 525 school districts, says her school board is committed to gender equity. In districts where communities have not yet made that commitment, Fraser urges school leaders to appeal to "self-interest" in getting the issue on the agenda.

With nearly 45 percent of female-headed households with children living in poverty, she says superintendents and school boards who take gender equity seriously could contribute greatly to their communities' economic well-being.

"At the school district level, we cannot ignore 50 percent of our students. At the national level, we need all students to be successful in order to be globally competitive," Fraser says.

Many advocates of classroom reforms to improve female student achievement point out that emphasizing hands-on exercises, problem-solving, cooperative learning, and more diverse role models will help all students become better educated.

Toward this end, says Petros, the assistant principal in Mount Clemens, "We made a decision a long time ago not to have an add-on ... two weeks of women in history or whatever. It's not a women in science week. Throughout every unit, you infuse information about women."

Thus, besides offering seven days a year of "special sessions" targeted to things like resume-writing, study skills, goal-setting, and making choices and decisions, Petros says gender equity encompasses less discrete issues such as curriculum reform; cooperative learning in heterogeneous groups; less reliance on textbooks and more on outside resources; nontraditional assessment practices; and new disciplinary methods.

Yet others point out that even though achievement gaps by gender may not begin appearing until the middle school grades, they are the result of curriculum and instruction beginning at the earliest grades.

At a meeting of the National Council on Educational Standards and Testing, a group created last summer by Congress, the president of the National Council of Teachers of Mathematics charged that the majority of teachers nationwide consider themselves reading specialists.

Thirteen states have no math requirement for elementary school teachers, 14 states have no science requirement, and half the states do not require a methods course in science for elementary school teachers. Most elementary school teachers have taken one college course in mathematics, one in geology, and one in physical science, says Russell Aiuto, director of research and development for the National Science Teachers Association.

With elementary school teachers overwhelmingly female and many times averse to science and mathematics themselves, professional development in these areas, plainly, must be a key component of programs to address female achievement.

"An important goal of equity programs must be to break the cycle whereby another generation of females who do not learn science become educators who do not teach science," says a "report card" on gender bias in math, science, and technology from the Mid-Atlantic Equity Center and the New England Center for Equity Assistance.

Yet school district policies don't always recognize that relationship.

For example, when Linda Sciaroni, a junior high teacher in East Los Angeles, won a fellowship from the American Association of University Women last year to return to school to take fundamental science courses, the school district rejected her application for a year's leave. The local commission on sex equity appealed on her behalf, and the district relented.

"It took that kind of bucking the bureaucracy," says Cassyd, the sex equity director.

Financial Roadblocks

Meanwhile, gender equity is forced to compete with the litany of other concerns school leaders face in ever more constraining budgetary times. For example, in the Charlotte-Mecklenberg, N.C., schools, Jennie Holt, an employee assistance specialist, says her district took a leadership role in

Where to Turn for Resources on Gender Equity

School district leaders can use the following resources as they address gender equity issues.

The first 10 are regional desegregation assistance centers federally funded under Title IV.

The Network
300 Brickstone Square, #900
Andover, Mass. 01810
Contact: David McConkey
508-470-1080

New York University
32 Washington Place, #72
New York, N.Y. 10003
Contact: Donna Walters
212-998-5100

Mid-Atlantic Equity Center
5010 Wisconsin Ave., N.W., #310
Washington, D.C. 20016
Contact: Sheryl Denbo
202-885-8517

Southern Educational Foundation
8603 S. Dixie Highway, #304
Miami, Fla. 33143
305-669-0114

University of Michigan
School of Education, #1033
Ann Arbor, Mich. 48109
Contact: Percy Bates
313-763-9910

Intercultural Development Research Association
5835 Callaghan, #350
San Antonio, Texas 78228
Contact: Jose Gardenas
512-684-8180

Kansas State University
School of Education
Manhattan, Kan. 66506
Contact: Charles Rankin
913-532-6408

Mid-Continental Regional Education Lab
12500 E. Iliff, #201
Aurora, Colo. 80014
Contact: Shirley McCune
303-337-0990

Southwest Regional Lab for Educational Research and Development
4665 Lampson Ave.
Los Alamitos, Calif. 90720
Contact: Harriet Doss-Willis
213-598-7661

Interface
4800 S.W. Griffith Drive, #202
Beaverton, Ore. 97005
Contact: Esther Puentes
503-644-5741

Consortium for Educational Equity
Rutgers University
Kilmer 4090
New Brunswick, N.J. 08903
908-932-2071

National Coalition for Sex Equity Educators
One Spruce Road
Clinton, N.J. 08809
908-735-5045

Mathematical Association of America
1529 18th St., N.W.
Washington, D.C. 20036
Contact: Siobhan Chamberlin
202-387-5200

Computer Equity Expert Project
Women's Action Alliance, Inc.
370 Lexington Ave., #603
New York, N.Y. 10017
Contact: Jo Sanders
212-532-8330

EQUALS
Lawrence Hall of Science
University of California
Berkeley, CA 94720
Contact: Nancy Kreinberg
415-642-1823

National Science Teachers Association
1742 Connecticut Ave., N.W.
Washington, D.C. 20009
Contact: Russell Aiuto
202-328-5800

National Council of Teachers of Mathematics
9806 Association Drive
Reston, Va. 22091
703-620-9840

addressing the mathematics gap in the early 1980s using a program called EQUALS from the Lawrence Science Center at the University of Berkeley.

However, when grants for the program ran out a year ago, the district failed to pick up the cost of administrative staff. This year, no substitute days will be provided for math instructors to participate in in-service connected with EQUALS, Holt says.

Even in Los Angeles, where a 29-member sex equity commission funded by the school board tackles issues from services for pregnant and parenting teens to professional development for teachers, Cassyd senses her existence is ever tenuous.

In 1983, budget cuts threatened to ax the sex equity commission. It survived, with the director's job funded as a teaching position. This year, support staff was cut back, and the district's Title IX coordinator was eliminated.

"It's a sign of the times that we have to be eternally vigilant. In tight budget times, civil rights can be the first thing to go," Cassyd says.

But she notes categorical funds, used to combat dropouts, drug abuse, and teen pregnancy, can be used to address gender equity.

Adds Hofstra University's Shakeshaft: "The real issue is trying to talk districts into saying this is important. There are not a lot of districts that have done that."

Why is science education so important?

Science and technology are powerful forces that shape human life on earth. They have enormous potential to make our lives better and richer, to keep our world safe and liveable, and to make our society productive and progressive. Science education needs to help fulfill the potential of science and technology by ensuring that they are used effectively, creatively, and wisely.

Although recent public debate has focused largely on the economic reasons for why science education is important, many scientists and researchers feel that other reasons are even more compelling. The first reason is personal fulfillment. The study of science enriches people's lives. Science lights the dark and frightening corners of the world. It opens the human mind to new aesthetic and intellectual pleasures and to a new appreciation of the beauty and precision that surrounds them. Science education empowers people to take greater control of their lives and to face problems with courage and understanding. It liberates them to imagine new questions and to set about finding new answers.

The second reason is the welfare of society. All citizens need to be scientifically literate to function effectively in an increasingly technical age and to help create and sustain a decent, just, and vigorous society. A scientifically literate person is one who understands the key concepts and principles of science and uses scientific knowledge and ways of thinking in everyday life. Citizens today face a range of hard choices — from the personal, such as how to avoid contracting AIDS, to the global, such as what to do about acid rain. People who understand science are better prepared to sort fact from myth, make sensible decisions, and urge their leaders toward enlightened public policy choices.

The third reason for science education being so important is economic. The nation will continue to need well-educated scientists, engineers, and technicians to push the envelope of knowledge and rekindle the spirit of invention and discovery that built our nation. We will also need people who are scientifically literate in a range of fields, including those that are not ostensibly scientific or technical. New technological and workplace demands are increasing the need for workers who have flexible skills, a basic grasp of science and technology, and the ability to solve problems and to think critically.

Reprinted with permission of the Council for Educational Development and Research from EDTALK: What We Know About Science Teaching and Learning by Nancy Kober. 1991, 3-5.

Although recent public debate has focused largely on the economic reasons for why science education is important, many scientists and researchers feel that other reasons are even more compelling.

Why do we need to change the way science is taught and learned?

Most schools use a conventional approach to teach science. Science is presented as a fixed body of facts, principles, and definitions, ordered sequentially and segregated by discipline and topic. Learning is dispensed by the teacher and the textbook, with students expected to master a range of topics by listening and reading. Instead of acquiring understanding in context, students learn isolated bits of knowledge, or "factoids": Name the noble gases. Point to the ribosomes in a drawing of a cell. Give the formula for calculating density.

This conventional approach to science education is not working for most students. Scientists, researchers, educators, and business people agree on this point, and the evidence supports their perceptions.

Most adult Americans are not scientifically literate. According to one recent poll, one-half the public did not know that the earth revolves around the sun once a year, and one-half mistakenly believed that early humans lived at the same time as the dinosaurs.

According to one recent poll, one-half the public did not know that the earth revolves around the sun once a year, and one-half mistakenly believed that early humans lived at the same time as the dinosaurs.

Of particular concern are the generations now moving through the educational system or through young adulthood. Two decades of data from the National Assessment of Educational Progress (NAEP) — a federally funded project that measures changes in student achievement in key subjects — show that despite upturns in 1980s, the average science achievement scores of students at ages 13 and 17 remain below 1969 scores. The achievement of nine-year-olds is about where it was in the 1970s. Recent increases only offset an earlier drop.

Although international assessments are fraught with methodological problems and limited in their ability to compare different cultures, the low to middling ranking of U.S. students in these studies corroborates the need to improve science education for all students.

Even if one leaves aside international comparisons, statistics on U.S. students' progress through the science pipeline — the channel that leads from elementary science through secondary school courses, and on to college majors and careers in science, engineering, and technology — point to serious problems. Somewhere in the middle grades, most U.S. students lose interest in science. By high school, many students of all achievement levels find science difficult, boring, and irrelevant. Fifty-five percent of students do not complete a chemistry course and 80 percent do not take physics. A disproportionate share of these students are girls, minorities, and non-college-bound youth. Schools may even treat more advanced courses as filters, discouraging all but high-achieving students and those with an expressed interest in scientific and technical careers from continuing science studies.

Moreover, most schools do not even truly consider science a core subject.

The result is that only a slim percentage of young people graduate with the knowledge, skills, and motivation that constitute scientific literacy, let alone with the background to successfully tackle college science or pursue science-related careers.

According to many researchers, scientists, and educators, these troubling statistics are symptomatic of the weaknesses in the conventional approach to science education — an approach that emphasizes breadth over depth, seatwork over activity, memorization over critical thinking, and recitation over well-reasoned argument. Moreover, most schools do not even truly consider science a core subject. In many elementary classrooms, science has all but vanished from the curriculum. According to a 1986 NAEP study, more than two-thirds of third-grade teachers reported spending two hours or less per week on science. And as the aforementioned statistics on enrollments in advanced courses show, high schools do not view science as a basic for all students.

Partly, science does not receive the attention it warrants because teachers themselves do not feel comfortable teaching science and have not received the preparation and inservice training they need to become proficient science teachers. But it is hardly fair to blame teachers for a problem that is much more endemic. Teachers have numerous competing demands on their time, including competition from other areas of education that receive greater support and attention from school administrators, parents, the public, and society.

For all of these reasons, groups of educators, scientists, business leaders, and researchers have independently concluded that the time is ripe for a comprehensive redesign of science education so that it begins in kindergarten and continues uninterrupted through grade 12.

Reprinted with permission of the Mid-Atlantic Equity Center
from Mathematics and Science: Critical Filters for the Future
of Minority Students by DeAnna Banks Beane. (c) 1988, 19-24.

Summary and Implications

Student and Teacher Related Factors Influencing Minority Student Participation and Performance

STUDENTS: AFFECTIVE FACTORS

FACTORS	IMPLICATIONS FOR INTERVENTION
ATTITUDES	
Minority students have positive attitudes toward mathematics and science in the early grades.	1. To maintain these attitudes, students must continually be involved in challenging, "hands-on" activities related to their real world. (See Educational Programs.)* 2. They must see others, from a cultural background like theirs, who have maintained this interest in science and mathematics. (See Career Motivation and Professional Organizations.)*
PERSISTENCE	
Those who are most successful in mathematics and science have developed the ability to persist. Having the ability to persist in the face of conflict is essentially related to a positive self-concept.	3. To develop this quality, children must be encouraged through the teacher's feedback and guidance to persevere as they work their way through appropriately challenging problems and situations. 4. They must make decisions, experience success, receive praise and constructive criticism, and recognize the relationship between their decisions, their actions and their success. 5. Teachers may require training in identifying the key elements of persistence and in designing strategies to develop them in children.
STEREOTYPING	
Many teachers, majority and minority, as well as many minority students, tend to stereotype mathematics and science as white male domains.	6. Teachers should introduce male and female minority persons with mathematics and science-related careers. These role models can counteract race and sex stereotyping. (See Career Motivation and Professional Organizations.)* 7. The historical and contemporary accomplishments of minorities in mathematics and science must be systematically included in the curriculum. (See Career Motivation.)* 8. Students and teachers must become alert to the presence of race and sex stereotyping in instructional and advertising materials. (See Bias in Instructional Materials.)* 9. Multiethnic television programs developed to provide children with information about science concepts and careers should be used in the classroom and at home to counteract stereotyped images. (See Career Motivation.)*

---

*Appropriate resources are listed in Section VI, "Resources for Intervention," under the topical heading indicated by the ( ).

FACTORS — **IMPLICATIONS FOR INTERVENTION**

UTILITY

Minority students are less likely to understand how the study of mathematics and science is applicable to everyday life, and valuable to their future schooling and jobs.

10. Good counseling by teachers and guidance counselors can provide a realistic picture of the relationship between students' present actions and future course and career options.
11. Exposure to persons who use mathematics and science in the workplace expands minority students' awareness of the usefulness of these disciplines.
12. Science and mathematics should be taught in an interdisciplinary manner, enabling students to experience mathematics as an essential tool of science. (See Educational Programs.)*
13. Minority students must have many regular opportunities to use computers for more than drill and practice and computer-assisted instruction. Access to computer technology for creative activities increases motivation and awareness of useful applications of mathematics and science.
14. The curriculum should focus on problems, investigations, discussions, trips, and activities designed to integrate mathematics and science skills into the everyday experiences of the students.

INFLUENCE OF SIGNIFICANT OTHERS

Teachers, counselors, parents and peers have a role in shaping students' attitudes toward mathematics and science.

15. Encouraging minority students to take the more challenging educational path conveys a message of confidence in their abilities.
16. Positive, substantive interactions which communicate high expectations can become a self-fulfilling prophecy.
17. Interactions with successful older minority students, teamwork, peer tutoring and cooperative learning strategies are effective ways to positively utilize peer influence. (See Educational Programs.)*
18. Parent education programs help parents become aware of the importance of mathematics to their children's futures. Such programs should offer suggestions and activities for parents to use in nurturing children's interest in mathematics and science.

---

*Appropriate resources are listed in Section VI, "Resources for Intervention," under the topical heading indicated by the ( ).

STUDENTS: COGNITIVE FACTORS

FACTORS	IMPLICATIONS FOR INTERVENTION
PREVIOUS EXPERIENCES	
Minority students tend to perform best when the content is related to their previous experiences.	19. Mathematics and science instruction must provide out-of-school experiences to make up for experiential deficits. The school curriculum should include field trips to zoos, museums, laboratories, ponds, streams, vacant lots, farms, generating plants, planetariums, aquariums, various worksites, hospitals, college campuses, etc. 20. Instruction in the classroom must be designed to include the kinds of enrichment experiences which contribute to knowledge, build self-confidence and develop thinking skills.
ACADEMIC DEFICIENCIES	
Achievement test performances by minority students indicate growing competency in basic skills, but weakness in understanding and application of concepts.	21. Instructional programs which teach strategies for attacking and solving word problems in mathematics must be a curriculum component at each grade level. (See Educational Programs.)* 22. All instructional activities must be systematically organized with clear objectives. 23. Student progress in mathematics and science must be monitored daily. 24. Activity-based science programs, when implemented with sufficient teacher training and support, significantly improve minority student performance in science process skills, science content, mathematics and language development. (See Educational Programs.)* 25. Math labs with manipulatives and high-interest computer software can be used to develop competency in application of concepts. 26. Student teamwork and cooperative learning strategies improve motivation and achievement. (See Educational Programs.)*
LANGUAGE	
Language minority students are handicapped in English-speaking mathematics and science classrooms and on achievement tests.	27. Teaching mathematics as a component of bilingual programs can improve the achievement of Spanish-speaking children. 28. Activity-based programs in mathematics and science with built-in linguistic objectives can increase language proficiency. 29. Direct instruction in word problem solving should emphasize tools for decoding the words and phrases. (See Language.)*

---

*Appropriate resources are listed in Section VI, "Resources for Intervention," under the topical heading indicated by the ( ).

FACTORS	IMPLICATIONS FOR INTERVENTION
MISUSE OF TESTING AND TEST DATA	
The use of standardized test data to predict achievement and to assess ability is detrimental to minority students.	30. Tests should be used to determine a child's actual progress rather than his/her disability. 31. Teachers should receive training on the proper use of test data and the purpose of diagnostic, criterion-referenced, norm-referenced and pre- and post-tests. 32. Student performance on tests must be analyzed and errors examined to identify specific skill and concept deficiencies. 33. There must be flexibility in grouping. An analysis of errors on practice assignments and tests can be the basis on which flexible groups are formed. Activity-based science and mathematics programs also provide opportunities for flexible, heterogeneous grouping. 34. Tests should be culturally fair and should assess the skills and content actually taught. 35. The teaching of test taking skills should be integrated throughout the ongoing curriculum.
LEARNING STYLES	
Instructional strategies frequently do not complement the learning styles of many minority students.	36. Through observations and/or diagnostic assessments, the learning style preferences of students can be determined. (See Learning Styles.)* 37. Concept and skill mastery activities should include: manipulatives, experiments, listening, reading, discussion, audiovisuals, movement, practical experiences, group and individual work, contracts, learning centers, writing, role playing, simulations, interviewing, and computers for problem solving. 38. Teachers should receive training on teaching styles and learning styles followed by instructional support for developing and implementing alternative instructional strategies like those cited above.

---

*Appropriate resources are listed in Section VI, "Resources for Intervention," under the topical heading indicated by the ( ).

CLASSROOM FACTORS

TEACHER EXPECTATIONS

Educators often perceive minorities as having inferior ability. This perception translates into an expectation of low achievement which is communicated to and internalized by the minority child.

39. Honest self-assessment by educators is the first step in breaking this cycle. (See Teacher Expectations.)* Questions like these must be asked:

    a. Who are my low achievers? (Is there an overrepresentation of minority students in this group?)

    b. How do I relate to minorities and low achievers?

    c. Do I:
    - Interact more with high achievers and ignore and interrupt low achievers more frequently?
    - Ask more and higher level questions of high achievers and provide low achievers with questions that require only simple recall?
    - Follow up with probing questions for high achievers and call on someone else if a low achiever is unable to provide a prompt, accurate response?
    - Provide a longer wait time for high achievers to respond to a question and cut off response time for low achievers who hesitate?
    - Seat high achievers closer to the teacher's usual position and cluster low achievers further away?
    - Praise high achievers more often and criticize low achievers more frequently?
    - Provide supportive communications for high achievers and engage in dominating behaviors with low achievers?
    - Provide high achievers with detailed feedback and give less frequent, less accurate and less precise feedback to low achievers?
    - Demand more work and effort from high achievers and accept less from low achievers?

40. Once a staff is aware of the ways in which expectations are communicated to students, teachers can observe one another's interaction with identified low achievers and minority students. Individual teachers can then design plans for changing their own behavior in the classroom. (See Teacher Expectations.)*

---

*Appropriate resources are listed in Section VI, "Resources for Intervention," under the topical heading indicated by the ( ).

FACTORS	IMPLICATIONS FOR INTERVENTION
TEACHER ANXIETY: MATHEMATICS	
Teachers who do not have positive attitudes about mathematics are likely to provide inadequate instruction; additionally, they are poor models for mathematical competency and interest.	41. A staff assessment of attitudes toward mathematics will (1) identify teachers experiencing mathematics anxiety or avoidance and (2) provide an opportunity for teachers to openly discuss the problem. 42. Math-anxious teachers can form a group for discussion and activities designed to change attitudes. (See Teacher Anxiety in Mathematics and Science.)* 43. Effective inservice programs, tailored to the mathematics needs of the local school, can provide teachers with new understandings of content and teaching strategies.
TEACHER ANXIETY: SCIENCE	
Many elementary teachers avoid teaching science because they lack training in science content and science teaching methods, and they have no confidence in their ability to teach it.	44. Confidence and competency can be increased through regular participation in science inservice workshops which offer specific skills, techniques and materials. 45. There must be ongoing opportunities to try out new science activities before using them in the classroom. Time should be provided at workshops, faculty meetings or during prearranged preparation time. 46. Professional journals and other materials which focus on elementary school science often combine content and suggested strategies. (See Teacher Anxiety in Mathematics and Science.)* 47. The development of a supportive network which includes several science teachers from the middle or junior high schools and local college faculty should be established.
INSTRUCTIONAL PRACTICES	
A number of instructional practices have been associated with low achievement in minority students.	*See all of the above* for appropriate alternatives.

---

*Appropriate resources are listed in Section VI, "Resources for Intervention," under the topical heading indicated by the ( ).

Reprinted with permission of the Mid-Atlantic Equity Center from Mathematics and Science: Critical Filters for the Future of Minority Students by DeAnna Banks Beane. (c) 1988, 30-32.

Checklist for Equity in Mathematics and Science

Developed by the Mid-Atlantic Center for Race Equity
The American University

(This instrument was inspired by G. Fauth and J. Jacobs, "Equity in Mathematics: The Educational Leader's Role," *Educational Leadership* 36 (March 1980): 485–490.)

A. Starting Out

	MATHEMATICS			SCIENCE		
	Yes	**No**	**N/A***	**Yes**	**No**	**N/A***
1. Have you compared the achievement test data for your minority and majority students?	☐	☐	☐	☐	☐	☐
2. Do you have goals which target equity in minority student participation and performance in mathematics and science?	☐	☐	☐	☐	☐	☐
3. Have you developed a network with other administrators in your district or region who share your goals for minority students?	☐	☐	☐	☐	☐	☐
4. Do you have an intervention plan for achieving and maintaining your equity goals?	☐	☐	☐	☐	☐	☐
5. Have you involved your teachers and minority parents in the development and implementation of the intervention plan?	☐	☐	☐	☐	☐	☐

B. Building Student Support and Positive Self-Concept

	MATHEMATICS			SCIENCE		
	Yes	**No**	**N/A***	**Yes**	**No**	**N/A***
6. Do you have a system for the early identification of minority students with high exceptional ability and/or interest in mathematics or science?	☐	☐	☐	☐	☐	☐
7. Have you developed an effective peer support program for minority students with exceptional ability and/or interest? (a club, group projects, a special regrouping arrangement, etc.)	☐	☐	☐	☐	☐	☐
8. Does your school provide career education programs which make all students, parents and teachers aware of the importance of studying a minimum of three years of mathematics and science in high school?	☐	☐	☐	☐	☐	☐
9. Does your school provide programs and materials to help primary school parents and teachers capitalize on the natural interest and positive attitudes minority youngsters have for mathematics and science?	☐	☐	☐	☐	☐	☐

---

*N/A = not applicable

	MATHEMATICS			SCIENCE		
	Yes	No	N/A*	Yes	No	N/A*
10. Do you provide minority role models who are enrolled in school programs or work in careers related to mathematics, science or technology and who demonstrate a high interest in helping minority youngsters?	☐	☐	☐	☐	☐	☐
11. Do the children have frequent opportunities to interact with the minority role models?	☐	☐	☐	☐	☐	☐

C. Instruction

12. Do your mathematics and science programs include effective strategies to address specific academic deficiencies?	☐	☐	☐	☐	☐	☐
13. Does your mathematics program regularly include manipulatives to facilitate the understanding of concepts?	☐	☐	☐	☐	☐	☐
14. Is the science program activity based and student centered, emphasizing the development of science content and process skills?	☐	☐	☐	☐	☐	☐
15. Does your school assume responsibility for providing regular opportunities for minority students to master computer concepts?	☐	☐	☐	☐	☐	☐
16. Do you monitor the mathematics and science instructional materials for racism and sexism?	☐	☐	☐	☐	☐	☐
17. Do teachers examine the content of their instructional materials (narratives, pictures, analogies, examples, problems) to detemrine if there is a bias toward white males?	☐	☐	☐	☐	☐	☐
18. Do you provide instruction for teachers in how to handle bias in instructional materials?	☐	☐	☐	☐	☐	☐
19. Are the historical and contemporary contributions of minorities in mathematics, science and technology woven into the curriculum?	☐	☐	☐	☐	☐	☐

D. Developing and Training Staff

20. Do you hire and support minority teachers, especially those with a real or potential affinity for mathematics and science?	☐	☐	☐	☐	☐	☐
21. Do you encourage the development of leadership potential in minority teachers? (Minority students need to see other minority persons who are successful participants in the school environment.)	☐	☐	☐	☐	☐	☐

*N/A = not applicable

BEST COPY AVAILABLE

	MATHEMATICS			SCIENCE		
	Yes	No	N/A*	Yes	No	N/A*
22. Have you identified and assisted those teachers who are "math or science anxious?"	☐	☐	☐	☐	☐	☐
23. Have you considered "exchange teaching?" (One solution to the mathematics/science anxiety problem is to have those teachers who enjoy mathematics and science do all of the instruction in those disciplines.)	☐	☐	☐	☐	☐	☐
24. Do you provide and participate in ongoing staff development programs which focus on techniques for making mathematics more interesting?	☐	☐	☐	☐	☐	☐
25. Do you provide and participate in "hands on" workshops which prepare teachers for an activity-based science curriculum?	☐	☐	☐	☐	☐	☐
26. Do you provide staff development programs on teacher expectations and their role in minority student achievement?	☐	☐	☐	☐	☐	☐
27. Have you and your staff participated in inservice education programs on cognitive or learning styles?	☐	☐	☐	☐	☐	☐
28. Has your staff used diagnostic instruments which provide information about students' learning styles?	☐	☐	☐	☐	☐	☐

E. Evaluating Your Equity Plan

29. Do you continuously monitor minority student achievement and participation in classrooms and extracurricular mathematics/science activities?	☐	☐	☐	☐	☐	☐
30. Are the minority students actively participating in classroom discussions, experiments and projects?	☐	☐	☐	☐	☐	☐
31. Has there been an increase in minority student participation in science fairs and clubs?	☐	☐	☐	☐	☐	☐
32. Do bulletin boards, book reports and library activities regularly reflect minority involvement in mathematics and science (or technology)?	☐	☐	☐	☐	☐	☐
33. As a result of your school's intervention plan are more minority students becoming high achievers by the time they leave your school?	☐	☐	☐	☐	☐	☐
34. Are more minority students enrolling in advanced mathematics and science classes after entering secondary school?	☐	☐	☐	☐	☐	☐

*N/A = not applicable

SECTION II: EFFECTIVE SCIENCE AND MATHEMATICS EDUCATION

Activity 3: What Is Effective Science Education? 3-1

Activity 4: What Is Effective Mathematics Education? 4-1

Section II: Effective Science and Mathematics Education

The purpose of Section II is to illustrate principles of effective science and mathematics teaching and learning. Model lessons are used to demonstrate what science and mathematics educators recognize as effective components and practices. These activities are especially appropriate for people helping to make decisions about science and mathematics reform, such as administrators and community members who may not be up-to-date or particularly expert in these content areas. The activities in this section are:

- **Activity 3: What Is Effective Science Education?** This activity offers several model lessons that illustrate the inquiry process so critical to effective science teaching and learning. The lessons are then related to a set of principles that represent the national consensus emerging from the variety of current standards-setting activities.

- **Activity 4: What Is Effective Mathematics Education?** This activity also offers a choice of model lessons that illustrate important principles of mathematics teaching and learning. The lessons are related to the Curriculum and Evaluation Standards of the National Council of Teachers of Mathematics.

This *Toolkit* section has been used in many situations, including:

- In one state's NSF-funded systemic initiative, teams from school districts are the key to science and mathematics reform. Model lessons from Activities 3 and 4 were modeled for these teams. The teams then used the lessons "back home" to illustrate for teachers, administrators, parents, and members of the community what changes they were promoting for science and mathematics teaching.

- A large committee was assembled in a city school district to tackle the reform of its science and mathematics programs. Members included central office curriculum staff, teachers and administrators from every school level, representatives from science and mathematics-related businesses, and members of relevant community organizations. As part of their early learning about effective science and mathematics programs, they worked through several of the model lessons.

3 WHAT IS EFFECTIVE SCIENCE EDUCATION?

Audience:

- Individuals responsible for reform in science education.

Desired Outcomes for Participants:

- To articulate a vision of an excellent science program.
- To identify the characteristics of effective science curriculum, teaching, and assessment.
- To describe and illustrate what science is, how scientific knowledge is acquired, and how good science teaching reflects the process of science.
- To identify the learning outcomes of good science education.
- To recognize teaching that reflects the process of science and integrates important skills and scientific habits of mind.

Facilitator's Notes: The purpose of this activity is to help participants reflect on new directions for science education in three areas: curriculum, teaching, and assessment. It includes three model lessons: learning experiences that contrast sharply with the ways most educators are likely to have been exposed to scientific knowledge, which was largely by listening to lectures, reading about science, and having laboratory experiences designed to confirm results obtained by someone else. Activities that are central to the work of scientists, such as asking questions, finding out something that isn't already known, predicting outcomes, pursuing a long-term independent investigation, working in research groups, or presenting results in a forum, were unlikely to have been experienced by current educators.

Students and their teachers need opportunities to learn and practice all aspects of scientific discovery. Teachers and other educators need to understand the nature of inquiry and then how to plan for and orchestrate science programs. They need to develop a vision of what such programs should look like: what students should be doing, what teachers should be doing, what materials need to be available, how connections can be made to the real world, and how learning and teaching will be assessed. This activity includes three model lessons – *The Pendulum, How Much Water Is in a Carrot?* and *Whose Bones?* – that are designed to model many of these elements. In addition, we have included an exercise to help participants build a vision of an effective science program for their own settings.

In this activity participants begin to develop an understanding of effective science education – in effect, to know it when they see it. Since some participants may be quite removed from science – for example, they may be responsible for many areas of the curriculum – we have included very basic material. We encourage you to use all or parts of the activity, depending on the situation. For example, the *Pendulum* or *Carrot* lessons could constitute a good one-hour overview. For groups from the same school, the vision-building "walk through" helps them develop a common image of a good science program that they might aspire to build, while the lessons show what effective, inquiry-based science looks like.

The model lessons are quite different. Both *Pendulum* and *Carrot* lessons emphasize inquiry and use common materials; they are easily led by nonscience experts and are oriented to elementary school science. The *Whose Bones?* lesson is more appropriate for audiences concerned with middle and secondary schools. When presenting the lessons, it is important to stress that when they are used with students, they are part of a longer learning sequence that results in the outcomes indicated. None of the lessons is meant to stand alone. Participants should always discuss how such a lesson would be placed in a curriculum and for what purpose. Only then is the idea of an effective science "program" modeled.

Each model lesson features a list of student learning outcomes that are keyed to national standards for science and mathematics. (We include mathematics standards because of the keen interest in integrating the two content areas.) The two science standards documents, whose full citations are listed in **Additional References**, are:

> *The National Science Education Standards,* November 1994 draft (NRC); and
>
> *Benchmarks for Science Literacy*, 1993 (Benchmarks).

The mathematics standards are referenced to the National Council of Teachers of Mathematics' *Curriculum and Evaluation Standards* (NCTM); see **Additional References** in **Activity 4: What Is Effective Mathematics Education?** for full citation.

Five exercises follow: the *Pendulum Model Lesson* (3-1), the *How Much Water Is in a Carrot? Model Lesson* (3-2), the *Whose Bones? Model Lesson* (3-3), *Model Lesson Analysis* (3-4), and *Building a Vision of an*

Excellent Science Program (3-5). Each has its own list of materials, time requirement, facilitator's notes, and transparency and handout masters. The fourth exercise, *Model Lesson Analysis*, points to a set of principles that have been assembled from the documents listed in the **Additional References** below. Further, the last exercise, *Building a Vision of an Excellent Science Program*, reinforces a set of characteristics likely to emerge in the current standards-setting effort.

We urge you (and ask you to urge participants) to stay current with the National Research Council, whose national standards are scheduled for publication in 1995 (for more information or to be put on their mailing list, call 202-334-1399 or e-mail scistnd@nas.edu). When those are available, you may want to create a "scavenger hunt" similar to the one in **Activity 4-1: Standards for Learning and Teaching Mathematics**, in which the NCTM mathematics standards documents are explored.

Additional References:

Kober, Nancy. 1992. *EDTALK: What We Know About Science Teaching and Learning.* Washington, DC: Council for Educational Development and Research.

Laboratory Network Program. January 1995. *A Toolkit for Professional Developers: Alternative Assessment.* Portland, OR: Northwest Regional Educational Laboratory.

Loucks-Horsley, Susan; Roxanne Kapitan; Maura O. Carlson; Paul J. Kuerbis; Richard C. Clark; G. Marge Melle; Thomas P. Sachse; and Emma Walton. 1990. *Elementary School Science for the 90s.* Alexandria, VA: Association for Supervision and Curriculum Development and Andover, MA: The NETWORK, Inc.

National Center for Improving Science Education. 1991. *The High Stakes of High School Science.* Andover, MA: The NETWORK, Inc.

___________. 1992. *Building Scientific Literary: A Blueprint for Science Education in the Middle Years.* Andover, MA: The NETWORK, Inc.

National Research Council. November 1994 draft. *National Science Education Standards: Discussion Summary.* Washington, DC: National Research Council.

Project 2061, American Association for the Advancement of Science. 1989. *Science for All Americans.* New York: Oxford University Press.

___________. 1993. *Benchmarks for Scientific Literacy.* New York: Oxford University Press.

3-1 SCIENCE MODEL LESSON — THE PENDULUM

Desired Outcomes for Participants:

- To illustrate, through actual participation, the elements of an exemplary science learning experience.
- To demonstrate how, through well-structured investigation, students can learn principles of physical science, measurement, and mathematical relationships.

Student Learning Outcomes from National Science and Mathematics Standards:

The learner will:

- know that the greater the force that is applied to an object, the greater the change in motion the object will have, and the more massive the object is, the smaller the effect a given force will have (Benchmarks, 89);
- know that motion can be described as change in position with time, and can be represented on grids or graphs (NRC, V-79);
- know how to design experiments, predict outcomes, and draw conclusions based on the data gathered (NRC, V-74);
- understand that scientists can have different explanations for the same set of observations, but all scientists expect explanations to be logical arguments backed up by evidence (Benchmarks, 11);
- use pictographs and graphic representations to model problems (NCTM, 75);
- determine the reasonableness of results (NCTM, 37); and
- clarify problems using discussions with peers (NCTM, 75).

Materials:

- **Transparencies:**
  - *Science Reform Requires Change in Three Areas* (3-9)
  - *Swing Time Data Recorder* (3-10)

Source: This activity was adapted with permission of Carroll County Public Schools, Westminster, MD, from Hands-On Elementary Science Program. ©1992, 2-69 through 2-73.

- Assembled on a table:
  - spools of string
  - washers
  - scissors
  - data recording sheets/graph paper
  - masking tape

- Overhead projector, screen, overhead pens, blank paper, and pens or pencils

---

Time Required: One hour

Process:

1. Show the **Science Reform Requires Change in Three Areas (3-9)** transparency. Explain that this model lesson illustrates characteristics of effective science curriculum, teaching, and assessment.

2. Have participants form groups of two or three. Ask one member of each group to come to the materials table and get a spool of string and one washer.

3. The first group task is to examine the washer and string and note the properties of both. Ask the participants to list as many varied and unusual things as they can that the washer and string could be used for. Have one person act as a recorder. After about two minutes have each group come to consensus on the one idea they want to share with everyone. Have the groups report out.

4. Give each group the following task prompt: "Construct a pendulum with the provided equipment. Develop a general statement based on your collected data that relates the length of the swing arm (string) and the number of swings in ten seconds." In addition, tell the groups that "the lengths of the swing arm should be x, 2x, and 0.5x, where x represents the length of the swing arm. Ask them to save each of the pieces of string and be prepared to report the average number of swings for each length; make additional predictions, and design additional experiments to test your predictions."

   Note: In doing this lesson it is essential that the facilitator not give the answers to the things participants are discovering. Give as few directions as possible and allow each group to settle their own questions about such things as length, how to count the number of swings, how far back to pull the pendulum, and when to start counting, etc.

5. Have each group report out their average number of swings in ten seconds and record their values on the **Swing Time Data Recorder (3-9)** transparency.

   Note: At some point of the discussion someone will usually comment that the overhead is recording information out of order and that it should be changed. It is usually helpful to remind participants that we are trying to allow students to build their own understanding, not simply pass along information. By placing the lengths "out of order" you are asking participants to think and eventually build their understanding about the lesson and about science concepts.

   Ask for volunteers to give their general statement (this statement will probably be something similar to "the longer the string, the fewer the number of swings").

6. Use a piece of masking tape to label each length of string with two pieces of information: (1) the number of swings recorded in ten seconds, and (2) the length (either x, 2x, or 0.5x).

7. Next, hang the pieces of string in a line at the front of the room in order (ascending number of swings, descending number of swings, etc.) and ask the group to discuss the pattern that is developed.

   Explore the data recorded on the **Swing Time Data Recorder (3-10)** transparency. Be sure to address all concerns and questions brought up by the participants. Some questions to ask and areas to explore are:

   - Why are some of the values much higher than others? (Reason: Some participants will count a swing as an entire cycle – that is, over and back – and others will count the swing across as one and the swing back as two.)

   - Were there similar values for x, 2x, and 0.5x? How can these be explained? (Reason: If the participants used similar lengths for their lengths they should have similar values for the number of swings reported. Results will differ slightly, but the data should support their general statement.)

   - Explain that some people pulled the pendulum back to perpendicular before releasing, while others only pulled the pendulum back slightly before releasing. How did the "pull back" affect the data? (Answer: It does not affect the reporting of the general statement. The data are consistent regardless of the pullback.)

8. Have the small groups reform and ask the participants to use their data and observations to predict the number of swings in ten seconds for the lengths of 4x and 0.25x. Give them a couple of minutes to make their predictions and record them on the right side of the **Swing Time Data Recorder (3-9)** transparency.

9. Discuss the predictions made and the reasons shared by the participants.

10. Go to **Activity 3-4: Model Lesson Analysis** on page 3-29 to debrief the lesson.

SCIENCE REFORM REQUIRES CHANGE IN THREE AREAS

- INSTRUCTION: How should we teach?
- CURRICULUM: What should we teach?
- ASSESSMENT: How should we measure student learning?

SWING TIME DATA RECORDER

GROUP NUMBER	LENGTHS				
	X	2X	0.5X		
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

3-2

Science Model Lesson — How Much Water Is in a Carrot?

Desired Outcomes for Participants:

- To illustrate, through actual participation, the elements of an exemplary science learning experience.
- To demonstrate how, through well-structured investigation, students can begin to learn about cell structure and function.

Student Learning Outcomes from National Science and Mathematics Standards:

The learner will:

- plan and conduct a simple investigation (NRC, V-20);
- employ simple equipment and tools to gather data and extend the senses (NRC, V-21);
- know that plants and animals have a great variety of body plans and structures (Benchmarks, 104; NRC, V-29);
- articulate similarities and differences between basic problem-solving strategies (NCTM, 23); and
- clarify problems using discussions with peers (NCTM, 75).

Materials:

- **Transparency:**
  - *Science Reform Requires Change in Three Areas* (3-9)
- Assembled on a table:
  - carrots (with tops)
  - scales or balances
  - plastic wrap
  - hair dryers
  - paper towels
  - cheesecloth
  - old pantyhose
  - strainers
  - a variety of food graters
  - *Optional:* electric frying pan, toaster oven

Source: This activity was adapted with permission from *Food . . . Your Choice*, 1977. Courtesy of National Dairy Council.

- Overhead projector and screen
- Newsprint, easel, tape, markers, blank paper, and pens or pencils

---

Time Required: One and one-half hours

Process:

1. Show the **Science Reform Requires Change in Three Areas (3-9)** transparency. Explain that this model lesson illustrates characteristics of effective science curriculum, teaching, and assessment.

2. Ask participants to work in groups of two, three, or four, with each taking on one of these roles (in smaller groups, the first two roles are most important):

   - *creative thinker* will stimulate new ideas and brainstorming
   - *recorder* will record procedures and responses
   - *materials runner* will get materials
   - *includer* will see that everyone is participating
   - *taskmaster* will keep the group on task

   Ask the groups to talk for a few minutes about what they know about carrots. Have a few groups report their conversations to the large group.

3. Pass out one carrot to each group and ask them what they notice about the outside of the carrot, then ask them to break the carrot in half. Ask what they notice about the inside. Give them a couple of minutes to observe and then report their findings to the large group.

   Note: Invariably, groups will report that the inside is wet.

4. Ask the large group how much water they think is in a carrot. Ask each participant to jot down an answer on paper, then report out what they think, one at a time. List their responses on newsprint, with their initials next to their prediction.

   Note: Participants will use a variety of units of measurement, e.g., ounces, grams. It will be interesting later to discuss the dilemma of how to make accurate comparisons without a common unit of measurement.

5. After charting responses, give each group another carrot. Challenge the groups to find out how much water is in their carrot, using the materials on the materials table. Give them an appropriate warning about using electrical appliances safely. Ask them to keep track of the procedures they use and the results. Allow 30 minutes.

6. Then ask the groups to use newsprint to show their process and results visually without using narrative, although they may use single words. (This is the assessment activity.) Allow 15 minutes.

7. Ask each group to report out, posting their newsprint around the room. As the groups report out, write their findings on the old chart of how much water they predicted was in a carrot, using a different color as the groups report the actual amount of water they found.

   Note: Principal discoveries: (1) There is far more water than anybody thought; (2) the method they originally thought would work didn't; (3) learning from other groups helped; and (4) it's hard to compare answers without a common unit of measurement.

8. Use the Numbered Heads Together technique (see **Appendix B-4**) to analyze their learnings. Some useful questions are:

   - What did you learn about carrots?
   - Do you have additional questions about carrots?
   - If there is so much water in carrots, why don't they feel more watery? What holds them together?
   - What additional questions do you have about carrots?
   - What did you learn from other groups in terms of procedures used to find out how much water is in a carrot?
   - How much water do you think is in bread? How would you find out?

9. Raise the issue of relevance with the large group. Does anyone care how much water is in a carrot? Does it matter? Why invest so much work to answer the questions? Of course, the answer is in the context and placement of the activity in a science curriculum. Ask: Where would it fit? What would have come before? What

afterwards? What implications does that have for engaging, one-time lessons?

10. Go to **Activity 3-4: Model Lesson Analysis** on page 3-29 to debrief the lesson.

3-3 SCIENCE MODEL LESSON — WHOSE BONES?

Desired Outcomes for Participants:

- To illustrate, through actual participation, the elements of an exemplary science learning experience.
- To demonstrate how, through well-structured investigation, students can be introduced to the purposes of the skeletal system and the relationship between the form and function of individual bones.

Student Learning Outcomes from National Science and Mathematics Standards:

The learner will:

- develop explanations based on what they observe, differentiating explanation from description by providing causes for effects and establishing relationships based on evidence and logical argument (NRC,V-74);
- think critically and logically to make relationships between evidence and explanations (NRC,V-74); and
- understand that living systems at all levels of organization demonstrate complementarity of structure and function (NRC,V-82).

Materials:

- **Transparencies:**
  - *Science Reform Requires Change in Three Areas* (3-9)
  - *Bones W, X, Y, or Z* (3-23 through 3-26)
- **Handouts:**
  - *Whose Bones?* (3-27)
  - *Analysis Questions* (3-28)
- One set of bones for each group of three or four participants; four different bones per set, available from:

Blue Spruce Biological Supply
221 South Street
Castlerock, CO 80104
800-825-8522
$13.65 per Bone Survey Kit (one set of four bones)

Source: One-time permission to copy the attached materials has been granted by Kendall/Hunt Publishing Company. ©1991, 103-106, and ©1993, transparency 4 and 5 a-d.

- Overhead projector, screen, blank transparencies, and overhead pens
- Newsprint, easel, tape, markers, and pens or pencils

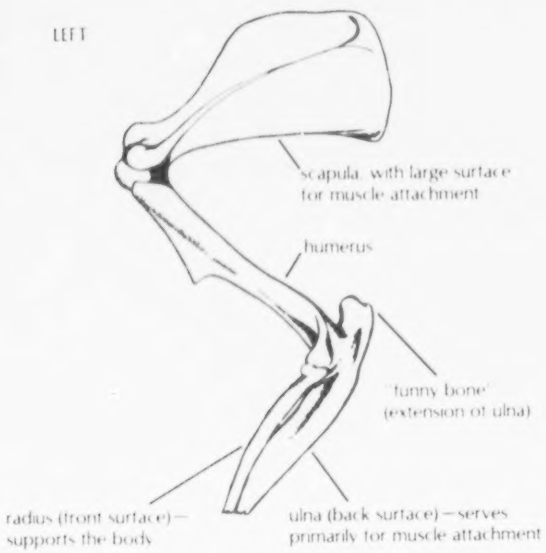
Time Required: One and one-half hour

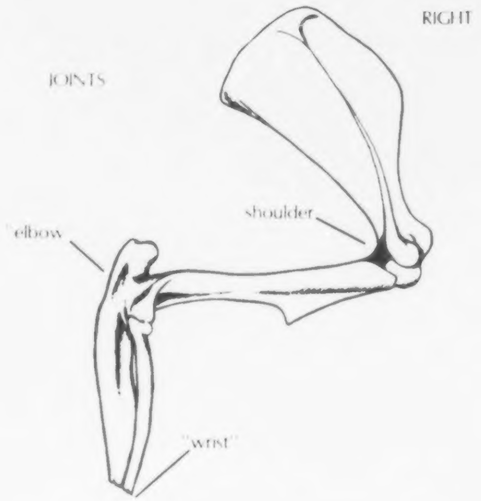
Facilitator's Notes: This model lesson is taken from a seventh and eighth grade life science program, *Middle School Life Science*, published by Kendall/Hunt and disseminated through the National Diffusion Network. The lesson introduces a set of lessons on bones within a unit on body structure. As with our other model lessons, it is important to note to participants that this lesson is not intended to be taught out of the context of the curriculum, since it fits into a carefully developed sequence of knowledge and skill development around this topic. Specifically, the lesson emphasizes the major concept of structure and function, as well as inquiry skills. In addition, it allows the teacher to introduce facts (in this case, the names of the bones) after understanding has been developed and only as many facts as students have interest in and can use. As noted in Process Step 5, as a facilitator you will have the option of sharing as much detailed information about bones with participants as you feel is appropriate. The following Bone Keys give you that information. You may want to make a second set of transparencies of the bones and write this more detailed information on them.

BONE KEYS

W = rat scapula, humerus, and ulna/radius

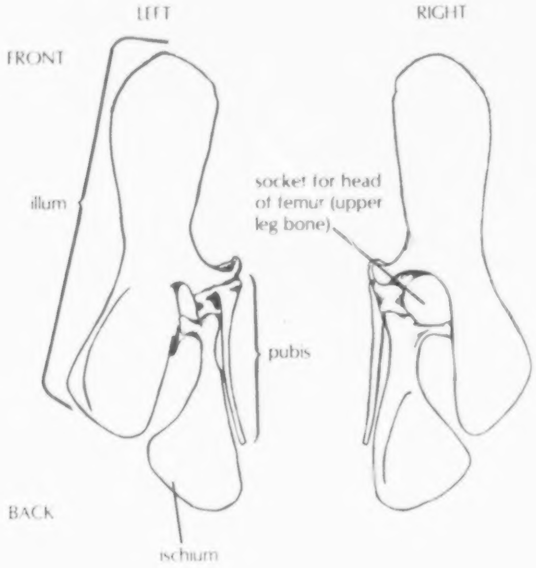
This is obviously a mammal scapula. A bird's scapula would look very different because its forelimb – wing -- does not function the same as does an arm or front leg. A fish doesn't even have a scapula, but it doesn't need one because its forelimb is reduced to a fin.


LEFT
scapula, with large surface for muscle attachment
humerus
"funny bone" (extension of ulna)
radius (front surface)—supports the body
ulna (back surface)—serves primarily for muscle attachment


RIGHT
JOINTS
shoulder
"elbow"
"wrist"

X = chicken pelvic girdle

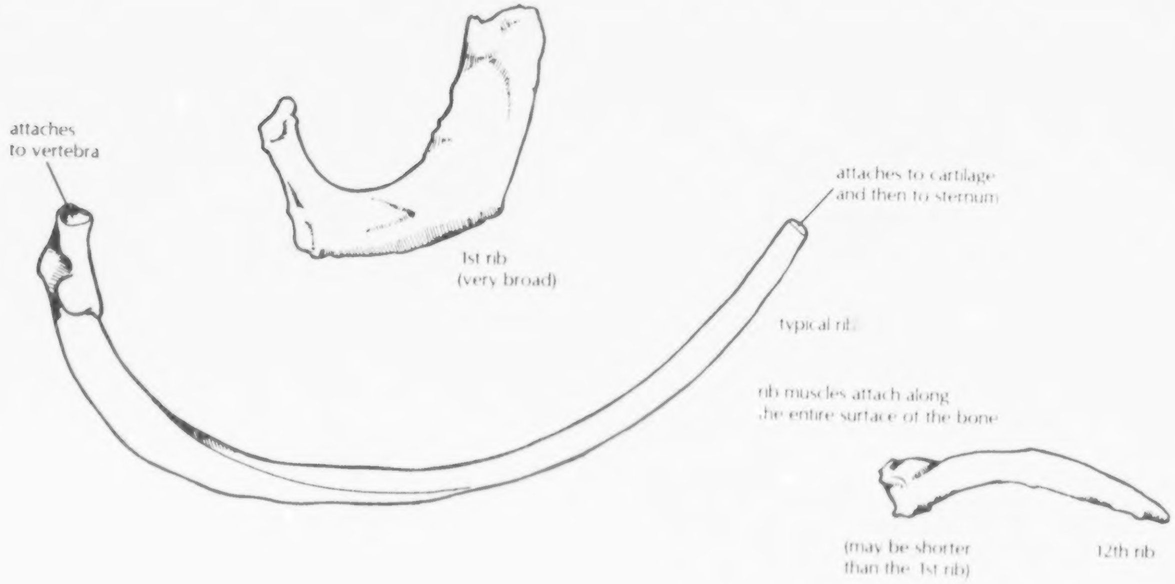
Bird bones are hollow, contain air spaces, and tend to be fused together. This permits the greatest strength with the least weight. The pelvic girdle is an example of a fused bone. In the chicken, it is possible to see the three bones that form this structure.


LEFT
RIGHT
FRONT
illum
socket for head of femur (upper leg bone)
pubis
BACK
ischium

Note that the fusion between the two pubic bones – which is found in the human pelvic girdle – does not occur here. This is a structural adaptation for the laying of eggs.

Y – human rib

Humans have an average of 12 ribs on each side, or 12 pairs in all. A person may have an additional pair in the neck (cervical) or lower back (lumbar) regions. The upper seven pairs connect to the vertebrae and curve forward to attach to the sternum by way of a piece of cartilage. These seven pairs are often referred to as "true ribs."


attaches to vertebra
1st rib (very broad)
attaches to cartilage and then to sternum
typical rib
rib muscles attach along the entire surface of the bone
(may be shorter than the 1st rib)
12th rib

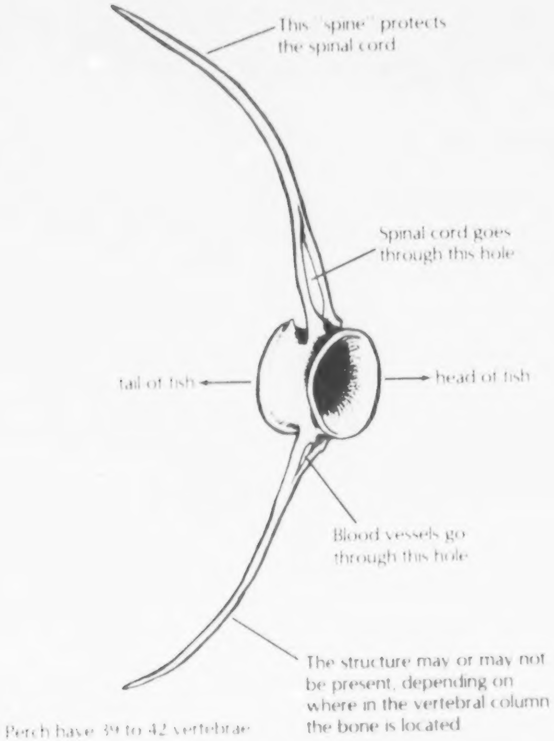
The remaining five pairs are sometimes termed false ribs. The first three pairs of false ribs have cartilage that attach to the cartilage of the rib above. The last two pairs are free at one end, which is why they are called floating ribs.

Ribs are among the most commonly broken bones. A rib is held by numerous chest muscles to nearby ribs. Thus, a broken rib does not require casting; it is held together naturally.

Ribs increase in length from the first to the seventh and then decrease from the seventh to twelfth. The top ribs are the broadest.

Z – perch vertebra

Fish bones are delicate and easily broken. The skeleton of a fish does not need to support a lot of weight since fish live in water. Thus, the bones do not have to be strong. They may even look transparent.


This "spine" protects the spinal cord
Spinal cord goes through this hole
tail of fish
head of fish
Blood vessels go through this hole
The structure may or may not be present, depending on where in the vertebral column the bone is located
Perch have 39 to 42 vertebrae

Process:

1. Show the **Science Reform Requires Change in Three Areas (3-9)** transparency. Explain that this model lesson illustrates characteristics of effective science curriculum and teaching.

2. Tell the participants that this model lesson is the introduction to the topic of bones within a seventh or eighth grade unit on body structure. Begin with this scenario:

   Imagine that you've been hiking in the woods for several hours when you finally reach your destination, a beautiful mountain lake. Immediately you feel as if the lake belongs to you. No one *else is around. The grasses are not trampled and there is no litter to be seen. It's so quiet; all you hear is the wind in the trees, the chatter of a squirrel, and the occasional quack of a duck.*

Walking more slowly now, you scan the lake shore, looking for a place to rest. Ahead of you some whitish objects catch your eye. Are they flowers? Rocks? As you get closer, you see that they aren't flowers or rocks. Then you wonder if perhaps they could be pieces of driftwood. No! They're bones! Bones of various sizes and shapes are scattered all around the area. Curious, you pick up the nearest bone. As you begin to examine it, you notice that some of the other bones look very different from the one in your hand. One by one you examine several of the bones. You wonder, How did these bones get here? What animals are they from?

3. Then tell the participants that this lesson addresses the question, What can you learn about an animal by observing one of its bones? Since most people older than elementary school students have studied bones at one point or another, begin by finding out how much participants know by using questions such as:

    - What bones can you name?
    - What bones do you think you can recognize?
    - Is it possible to tell what kind of animal a single bone is from? How?
    - Which living things have bones?
    - Are there any animals that do not have bones?
    - Why does an animal need bones? What functions do bones serve?

4. Form participants into groups of three or four. Distribute the handouts **Whose Bones? (3-27)**, **Analysis Questions (3-28)**, and a bag of bones to each group. Explain that each group has four bones to inspect. For each bone, they should complete the column on the handout **Whose Bones**. Then they should discuss and record their answers to the **Analysis Questions (3-28)**. Allow 50 minutes.

5. When they are finished, discuss one of the bones:

   - Have participants refer to their data tables and identify features they recorded about the bone. Explain that these should include observations only – features that can actually be seen. Jot down some of their observations on newsprint.

   - Continue to discuss the other items on the data page. Notice how participants interpret the clues and decide where on the animal's body this bone could be found. Remind them that when they interpret clues, they are using observations to make inferences. Point out that not everyone will make the same inferences.

   - Use the transparency for this bone (**Bone W, X, Y, or Z [3-23 through 3-26]**) to extend the discussion.

   Indicate additional observations that you might use as clues. For instance, one observation for bone X, the chicken pelvic bone, might be that it has a round indentation halfway between the two ends of the bone.

   Explain how you might interpret your observations. For instance, you might infer that something, perhaps the rounded end of another bone, fits into the round indentation.

   Reveal the identity of the bone if participants have not yet determined it.

   Discuss any other interesting information about the bone from this animal that you wish to bring out (see the Bone Keys in the **Facilitator's Notes**).

6. Follow a similar format for discussing the other three bones.

7. Discuss the first four analysis questions. Listen to the answers. Pull together their responses into one good, clear answer.

8. Summarize the concepts and skills that participants learned by doing this activity.

   - They can describe characteristics of bones based on their observations of four real bones. Examples include:

     – Each bone is unique, having its own characteristic shape, bumps, grooves, and smooth surfaces.

  - All bones share features such as having tiny air spaces and being fairly hard, light in color, and relatively straight.

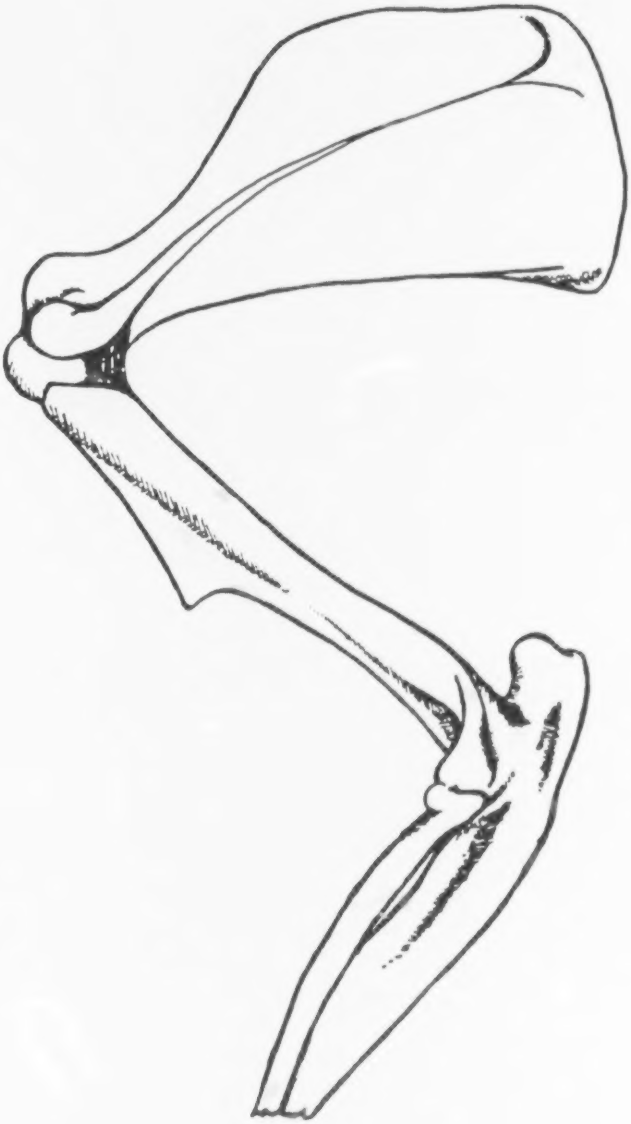
- They can give at least one example of how the structure of a bone relates to its function. Examples include:
  - A long bone provides support.
  - A curve in a bone, such as a rib, indicates that it curves around something: in this case, the lungs and heart. This might indicate a protective role.
  - A hole in a bone indicates that something goes through it such as a nerve, blood vessel, or spinal cord.

- They can infer some, but not all, characteristics of an animal based on observations of a single bone. Examples include:
  - It may be possible to infer physical characteristics such as height, weight, and mode of movement – flying, swimming, walking on all fours, or walking upright – by observing one bone.
  - It is not usually possible to infer nonphysical characteristics, such as intelligence, moods, vocalizations, and personality, by observing one bone.

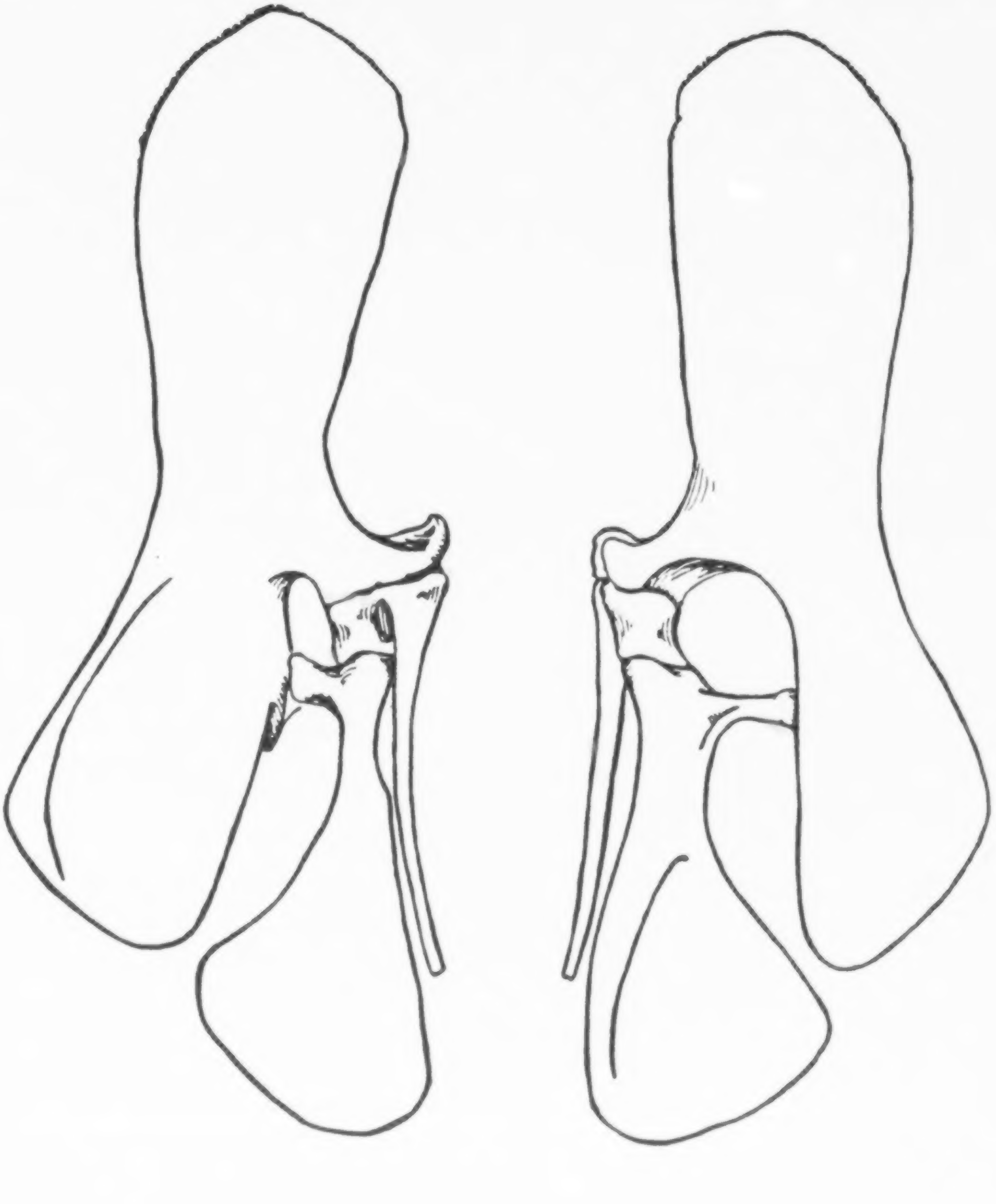
As an alternative, turn this summary into a set of questions and use the Numbered Heads Together technique (see **Appendix B-4**) to have participants determine their own learning.

9. Go to **Activity 3-4: Model Lesson Analysis** on page 3-29 to debrief the lesson.

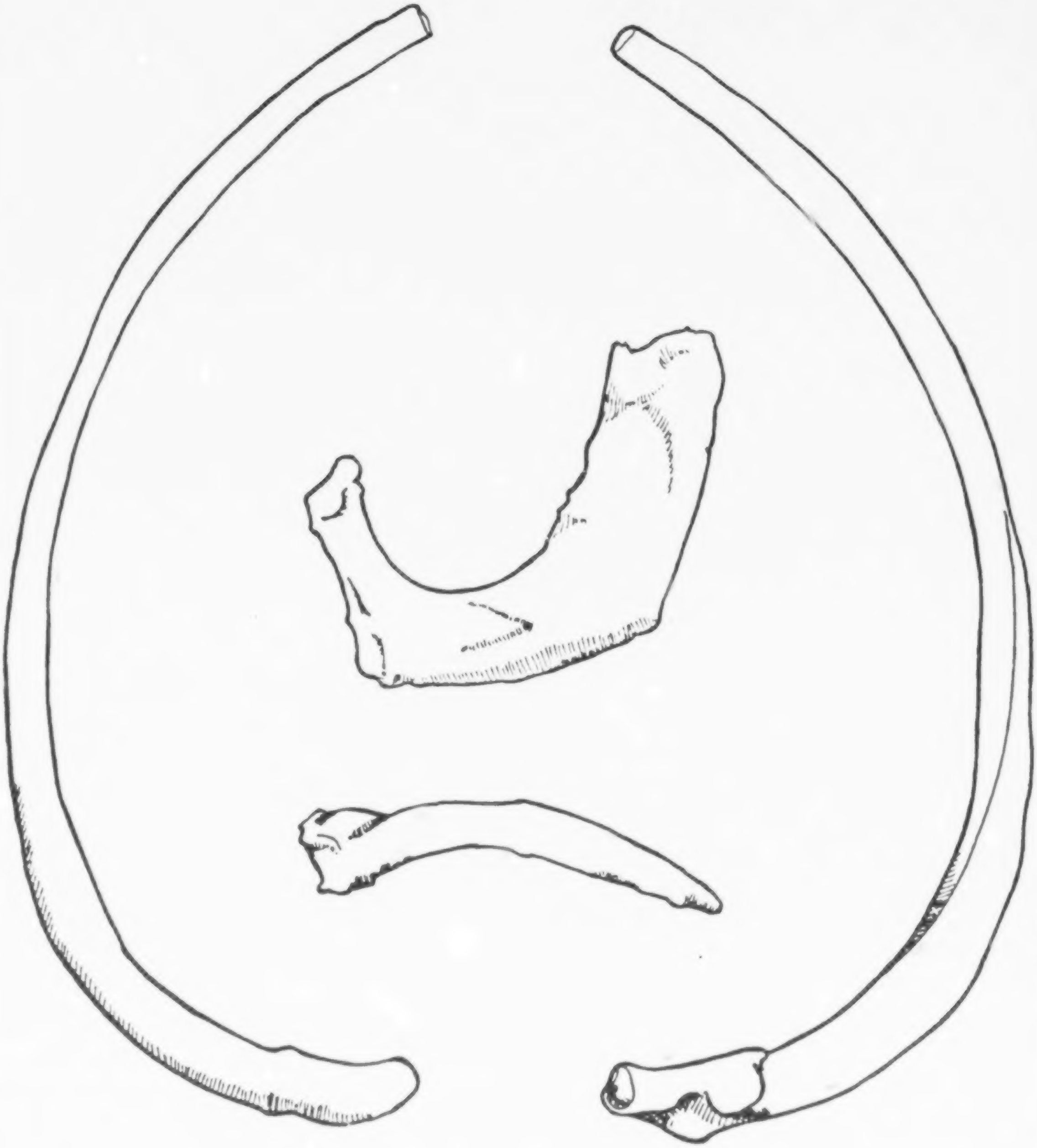
BONE W



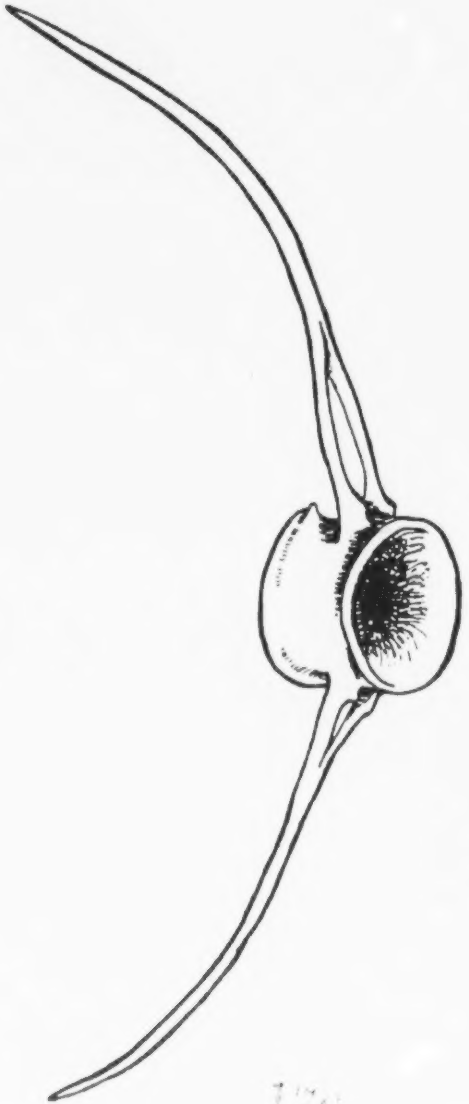
BONE X



BONE Y



BONE Z



WHOSE BONES?

Names: ____

	BONE W	BONE X	BONE Y	BONE Z
1. List at least four features about this bone that might give you clues about the animal.				
2. Interpret these clues. What do they tell you about the animal?				
3. Where in the animal's body do you think you would find this bone? Give a reason for your answer.				
4. What could have been a function of this bone?				
5. What animal do you think this bone is from? Give a reason for your answer.				
6. What other animal(s) could this bone possibly be from?				

ANALYSIS QUESTIONS

1. List at least three things all the bones had in common.

2. List at least three ways that the bones differed from each other.

3. What functions could these bones have served?

4. What kinds of things can you tell about an animal by looking at one of its bones? Circle the items on this list that you could determine by looking at that animal's bones:

size
eye color
age
weight
diet
intelligence
if it could fly
the sound it makes
whether it's male or female
if it were sick or healthy
if it lived in water or on land
its favorite food

5. List at least three careers in which you might need to recognize bones.

6. If you really did find an assortment of bones on a lake shore, you probably would wonder how those bones got there. Give at least two possible explanations.

3-4 MODEL LESSON ANALYSIS

Materials:

- **Transparencies:**
  - *Activity Analysis* (3-32)
  - *Some Important Skills* (3-33)
  - *Some Important Scientific Attitudes* (3-34)
  - *Science Reform Requires Change in Three Areas* (3-9)
  - *Moving from Facts to Concepts* (3-35)
  - *Major Organizing Concepts* (3-36)
  - *You Can't Teach It All* (3-37)
  - *The Importance of Using a Conceptual Approach* (3-38)
  - *Teaching Model That Reflects the Nature of Scientific Investigation* (3-39)
  - *Good Science Education* (3-40)
  - *Moving Toward Good Science Education* (3-41)

- **Handouts:**
  - *Some Important Scientific Attitudes* (3-42)
  - *What Is Good Science Education?* (3-43)

- Overhead projector, screen, and overhead pens

Time Required: One-half hour to 45 minutes

Process:

1. Tell the group that you would now like to analyze the model lesson against some new directions in science education. Explain the Numbered Heads Together technique (see **Appendix B-4**), with each person in the group picking a number one to four; continue with the **Activity Analysis (3-32)** transparency.

   Cover the questions so only one question at a time is showing and participants can focus on that particular question. Show the first question, "How was the learning structured so that everyone participated?" and tell participants to put their heads together and try to come up with an answer for this question. After allowing 30 seconds or so, ask the number ones to raise their hands and pick one person to answer. Continue through the seven questions.

   By going through the series of questions, participants will get the sense that this lesson reflected something new about science education, that it was different from a typical lecture, and that it incorporated a lot of the new directions that science education is moving toward.

When you get to question five, show the **Some Important Skills (3-33)** transparency so participants can view the skills and then go back to the question. Do the same for question six with the **Some Important Scientific Attitudes (3-34)** transparency. (You may also want to distribute the handout **Some Important Scientific Attitudes [3-42]**.)

2. Show the **Science Reform Requires Change in Three Areas (3-9)** transparency and explain to participants that we have looked at the questions, "How should we teach?" and "How should we measure student learning?" through this series of lessons. Tell them now to focus on the middle question, "What should we teach?" Show the **Moving from Facts to Concepts (3-35)** transparency and say that instead of using facts or topics as the "content" goals for learning, it is now recommended by some reports (see **Additional References** on page 3-3) that science programs focus on learning major concepts instead. Read through some of the concepts on the transparency and relate back to the lesson they have just completed.

   For example, for the *Pendulum* lesson, point out the possible facts and topics, then go on to explain the three major concepts. **Cause and effect** were highlighted when participants discovered that the length of the string directly affected the number of swings. **Organization** was being developed as a concept in the wall chart of the pendulums by the number of swings. Before the lesson, participants were less clear about the **structure and function** of the washer and string. With experimentation, this simple object (structure) was able to function as a clock.

3. Show the **Major Organizing Concepts (3-36)** transparency and explain that an entire elementary, middle, or high school science program could be built upon a set of organizing concepts. These particular ones are recommended for elementary science by the National Center for Improving Science Education; a similar list exists for the other levels of schooling (see **Additional References** on page 3-3).

   Point out to participants that it is important to move toward a conceptual approach to teaching science for several reasons. Living in the information age quickly outdates textbooks in most content areas and presents new points of view to support or call into question theories once espoused by the science community. Scientific breakthroughs in highly specialized fields, such as genetics, immunology, and bio-engineering demand that we move away from instruction based solely on learning and assessing facts and rules. Show the **You Can't Teach It All (3-37)** transparency and point out that it is impossible, therefore, to teach it all, and important to recognize that content information and theories supported by the science community are under continual revision as new information and knowledge are acquired. In summary, it's much more important that students know how to process information and to perceive the moral implications and responsibilities of scientific endeavors.

4. Show **The Importance of Using a Conceptual Approach (3-38)** transparency and continue the discussion around why these major organizing concepts should be considered as a framework for science curricula.

5. Show the **Teaching Model That Reflects the Nature of Scientific Investigation (3-39)** transparency and ask participants how the lesson they participated in went through a similar cycle.

   For example, in the *Pendulum* lesson the invitation began with participants brainstorming different uses for the washer and string. The discovery happened during the trial and error swinging of the pendulum. After the strings were hung on a wall chart, participants came up with explanations and solutions – eventually preparing a graphic illustration of their learning.

6. Pass out the handout **What Is Good Science Education? (3-43)** and display the **Good Science Education (3-40)** transparency. Point out that these recommendations will help to promote science in the newer direction. Have participants look over points 1 through 10 and then display the **Moving Toward Good Science Education (3-41)** transparency.

   Ask the groups to discuss which of these action steps they have taken, which they might plan to take, and what are the implications of the recommendations for their department, school, district, or state. After allowing participants ten minutes to discuss the new directions, ask the groups to give examples for a few of the points.

7. Ask participants to refer back to their definitions of systemic change from **Activity 1: Framing the Dialogue Around Systemic Change**. How do the characteristics of good science programs mesh with systemic thinking? How can such programs be supported by the system?

ACTIVITY ANALYSIS

1. How was the lesson structured so everyone participated?
2. What aspects of the lesson allowed you to construct your own understandings of new concepts?
3. How does the amount of direct instruction compare with the way science is usually taught?
4. Where was the inquiry? What made you want to learn more?
5. What concepts were taught? How did this differ from learning disconnected facts?
6. Pick one skill from each category. How was it fostered in this lesson?
7. Which scientific attitudes were promoted? How?

SOME IMPORTANT SKILLS

Gathering information

- questioning
- observing
- classifying
- measuring
- collecting data

Process Skills

Answering questions and solving problems

- interpreting data
- inferring
- predicting
- hypothesizing

Conceptual Development

Making decisions

- designing experiments
- questioning
- designing, building, and testing models
- communicating results

Thinking Processes

SOME IMPORTANT SCIENTIFIC ATTITUDES

- Desiring knowledge
- Being skeptical
- Relying on data
- Accepting ambiguity
- Respecting reason
- Being honest
- Willingness to modify explanations
- Being aware of biases in doing science
- Willingness to fail and try again
- Recognizing the moral implications and responsibilities of scientific endeavors

Source: Adapted with permission of The NETWORK, Inc. from *Getting Started in Science: A Blueprint for Elementary School Science Education* by the National Center for Improving Science Education. ©1989, 18-19.

MOVING FROM FACTS TO CONCEPTS

An Example: The Pendulum

Facts

- One minute has sixty seconds

Topics

- Time
- Measurement
- Forces

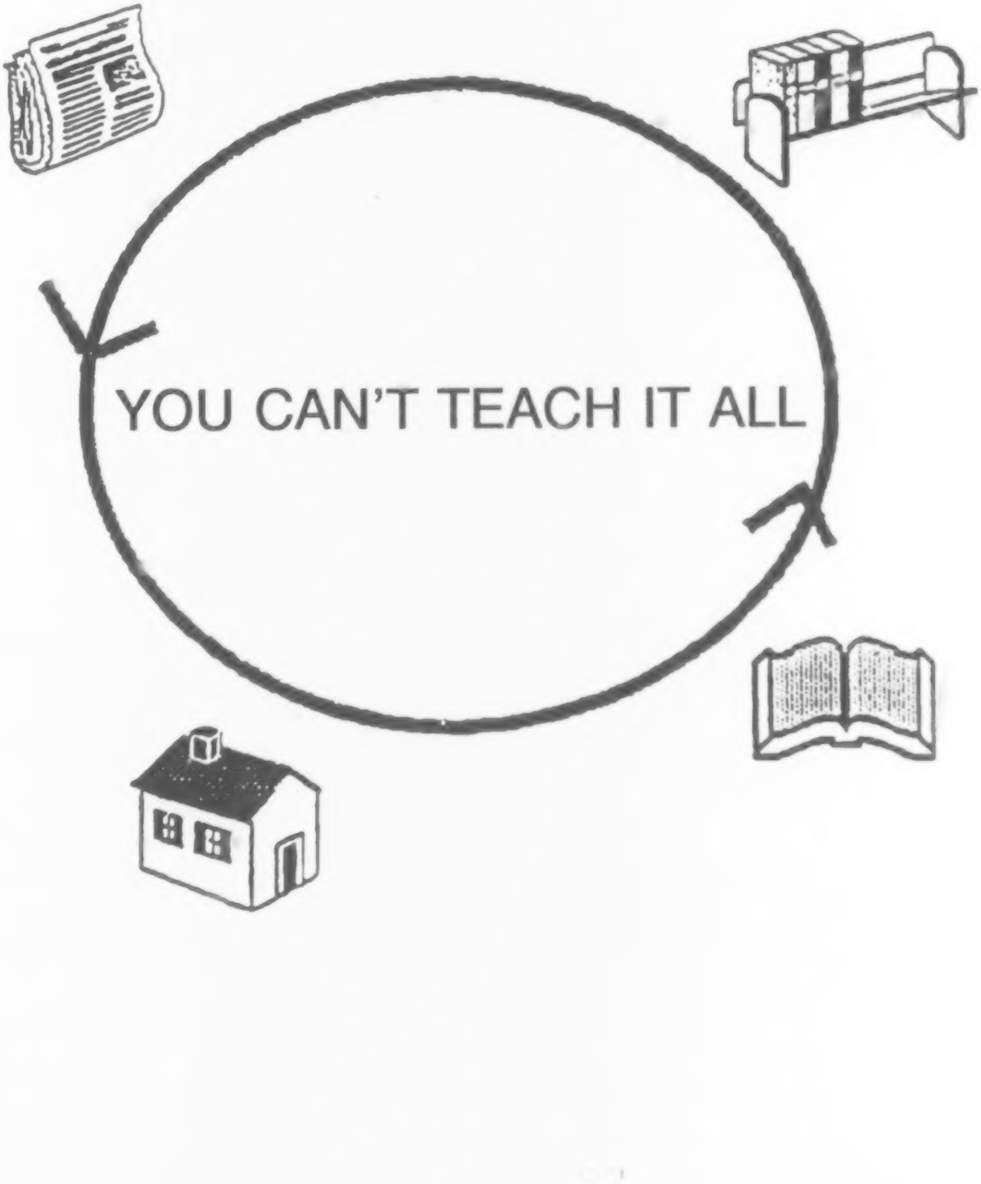
Concepts/ Themes

- Cause and effect
- Organization
- Structure and function

MAJOR ORGANIZING CONCEPTS

- Organization
- Cause and effect
- Systems
- Scale
- Models
- Change
- Structure and function
- Discontinuous and continuous properties (variation)
- Diversity

Source: Adapted with permission of The NETWORK, Inc., from *Getting Started in Science: A Blueprint for Elementary School Science Education* by the National Center for Improving Science Education. ©1989, 13-16.

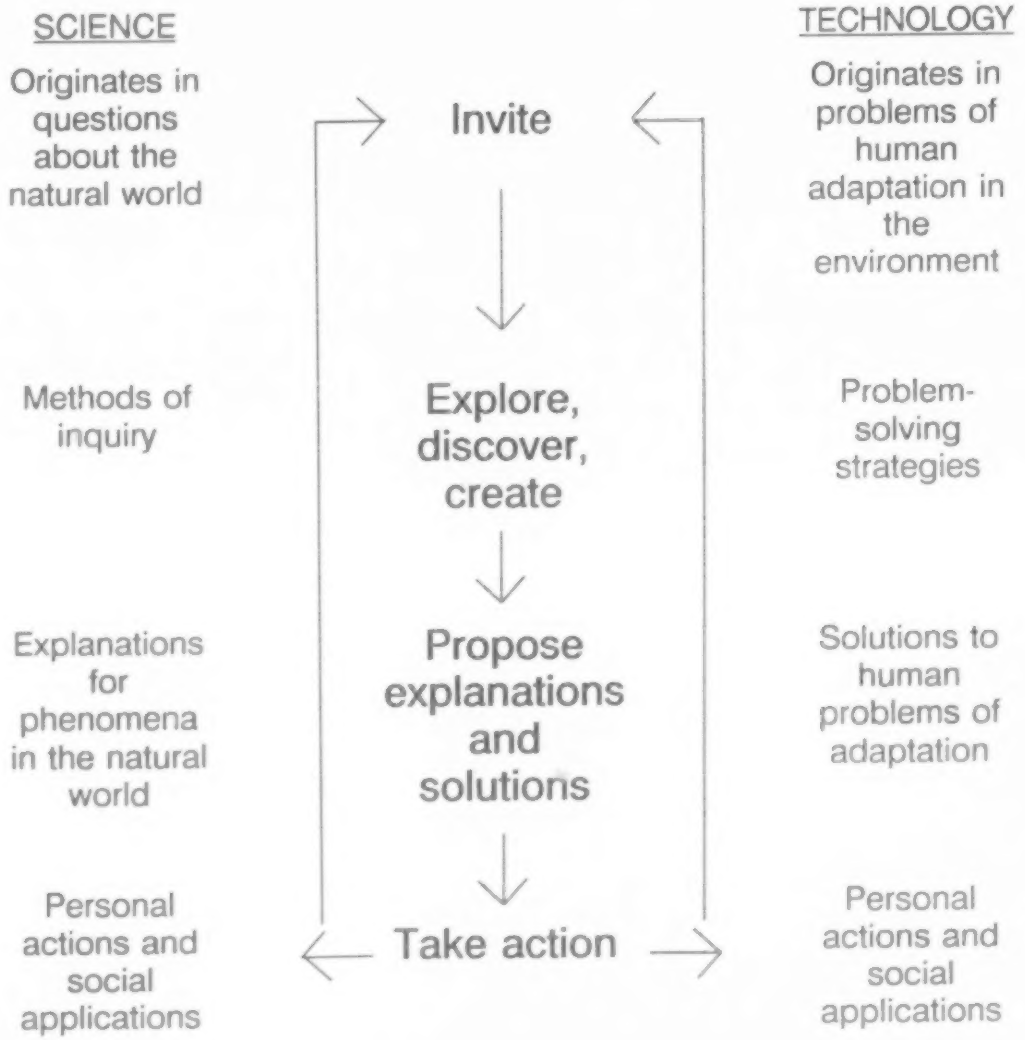


YOU CAN'T TEACH IT ALL

THE IMPORTANCE OF USING A CONCEPTUAL APPROACH

- Concepts bring coherence to the natural world
- Concepts promote greater understanding from fewer topics
- Concepts bring meaning to information and experience
- Concepts apply to the personal everyday lives of learners
- Concepts promote life-long learning

TEACHING MODEL THAT REFLECTS THE NATURE OF SCIENTIFIC INVESTIGATION



SCIENCE		TECHNOLOGY
Originates in questions about the natural world	Invite	Originates in problems of human adaptation in the environment
Methods of inquiry	Explore, discover, create	Problem-solving strategies
Explanations for phenomena in the natural world	Propose explanations and solutions	Solutions to human problems of adaptation
Personal actions and social applications	Take action	Personal actions and social applications

Source: Reprinted with permission of The NETWORK Inc. from *Building Scientific Literacy: A Blueprint for Science in the Middle Years* by the National Center for Improving Science Education. ©1992, 22.

GOOD SCIENCE EDUCATION

1. Achieves National Education Goals
2. Links science and technology
3. Involves students in DOING science
4. Helps students clarify, revise, and build models of the world
5. Teaches scientific skills and processes
6. Teaches habits of mind
7. Studies fewer topics in-depth
8. Balances life, earth, and physical sciences
9. Makes science accessible and attractive to ALL students
10. Assesses learning in an ongoing way with diverse approaches

MOVING TOWARD GOOD SCIENCE EDUCATION

Discuss:

- Which of these action steps have you taken?
- Which do you plan to take?
- What are the implications of these recommendations for your department/school/district/state?

SOME IMPORTANT SCIENTIFIC ATTITUDES

1. **Desiring knowledge**. Recognizing that science is a way of knowing and having a disposition toward knowing and understanding the world is important for elementary science education.

2. **Being skeptical**. A part of this attitude is recognizing the appropriate time and place to be scientifically skeptical and to believe that authoritarian statements and self-evident truths can be questioned.

3. **Relying on data**. Obtaining and ordering data are the basis for explanations of natural phenomena. Relying on data also means rigorous testing of ideas and respecting the facts as they are accrued.

4. **Accepting ambiguity**. Data are seldom clear and compelling; and scientific information seldom, if ever, proves something. New questions and problems arise out of ambiguity.

5. **Respecting reason**. Scientists value patterns of reasoning that lead from data to conclusions and eventually to construction of theories.

6. **Being honest**. Data should be presented as they are observed, not as the investigator thinks they ought to be.

7. **Willingness to modify explanations**. As data suggest different explanations of objects or events, one must be willing to change one's original explanation.

8. **Being aware of biases in doing science**. Even scientists cannot be completely objective at all times – preferences, beliefs, and cultural norms all impact professional duties at one time or another.

9. **Willingness to fail and try again.** Being "right" is not the goal of science. Through trial and error, learning and discovery are fostered.

10. **Recognizing the moral implications**. Students need to recognize that scientific and technological breakthroughs present unparalled opportunities, while creating moral and ethical dilemmas that challenge us to think critically and to act responsibly in our use of knowledge and technological tools.

Source: Adapted with permission of The NETWORK, Inc. from *Getting Started in Science: A Blueprint for Elementary School Science Education* by the National Center for Improving Science Education. ©1989, 18-19.

WHAT IS GOOD SCIENCE EDUCATION?

1. Good science education is the means to achieve National Education Goals that address student achievement, citizenship, and becoming first in the world in science and mathematics achievement respectively.

2. In good science programs, science and technology are linked. However, when we consider science, we think about answering questions about the natural world. Technology seeks to solve problems of human adaptation to the environment.

3. Effective teaching models reflect the ways scientific knowledge is acquired.

4. Effective science programs are designed to enable students to connect their observations and experiences with prior understandings, to challenge and clarify their models of the world.

5. Important skills are taught and learned in good science programs.

6. A set of "habits of mind" are included in a good science curriculum.

7. Effective science programs focus on in-depth study of a limited number of topics and the deepening understanding of a small number of key concepts instead of recitation of facts and vocabulary.

8. Effective science programs provide a rich and interconnected balance of life, earth, and physical sciences each year.

9. Effective science programs are accessible to all students. Students from all cultures, ethnic groups, and genders actively participate in classroom activities and achieve equally well. All are encouraged to go into fields that require preparation in science.

10. In an effective science program, assessment of the growth and development of student understanding is on-going and uses diverse tools.

3-5 BUILDING A VISION OF AN EXCELLENT SCIENCE PROGRAM

Materials:

- **Transparencies:**
  - *Science Reform Requires Change in Three Areas* (3-9)
  - *Science That Supports Emerging National Standards Is:* (3-47)
- **Handouts:**
  - *Walk-Through of Mountain View Middle School* (3-48 and 3-49)
  - *Science That Supports Emerging National Standards Is:* (3-50 and 3-51)
- Overhead projector, screen, and overhead pens
- Newsprint, easels, markers, tape, blank paper, and pens or pencils

Time Required: One to one and one-half hours

Facilitator's Notes: In this part, participants are led through an imaginary middle school where they "view" an excellent science program in action. This helps them put all the pieces together as well as imagine a supportive school environment for enabling good teaching and learning to happen. Process Step 4 allows them to test their own understanding about effective science programs against the emerging national consensus.

Process:

1. Show the **Science Reform Requires Change in Three Areas (3-9)** transparency and explain that this learning experience will help them build a vision of a new science program, with important changes in three areas: curriculum, teaching, and assessment.

2. Ask participants to number a piece of paper from 1 to 14, leaving a few lines between each number. Read each item from the **Walk-Through**, giving participants a minute to jot down their response for each item.

   Note: Do *not* distribute the handout **Walk-Through of Mountain View Middle School (3-48 and 3-49)** yet, since you want participants to develop images in their minds, not stare at a handout.

3. Divide participants into six groups. Give each group a sheet of newsprint with one of the six headings:

- School Environment (Questions 1, 2, 3, 4, 12)
- Curriculum – What to Teach (Questions 4, 7, 9, 10, 12)
- Teacher Development and Support (Questions 4, 11, 13, 14)
- Equitable Practices (Questions 3, 5, 8, 11)
- Assessment (Questions 4, 10, 11, 12)
- Instruction – How to Teach (Questions 1, 6, 7, 8, 12)

Ask each group to choose a recorder and reporter. Distribute the handout **Walk-Through of Mountain View Middle School (3-48 and 3-49)** so they can refer to the specific questions. Allow 20 minutes.

Have participants each share and record on newsprint the characteristics of their assigned component of the vision, drawn from their group's responses. Then ask the reporters to post the newsprint and summarize the work of the groups; ask for additions as each aspect of the vision is reported.

4. When all six sheets are on the wall, show the **Science That Supports Emerging National Standards Is: (3-47)** transparency and distribute the handout **Science That Supports Emerging National Standards Is: (3-50 and 3-51)**. Ask participants to read the handout and locate those items related to the aspect they reported on newsprint. Ask them to make any changes or additions they identify on the handout. Have groups briefly report out their changes and facilitate a discussion of their elaborated vision.

   Refer participants back to their definitions of systemic change from **Activity 1: Framing the Dialogue Around Systemic Change**. How do aspects of their system support or inhibit their vision for a science program? What can *they* do to move towards a more systemic view?

5. Ask participants to reflect on, talk about, and/or write: What have I learned in this activity? How can I use what I've learned?

Science that supports emerging national standards is:

- A curriculum for ALL students
- A problem-solving activity based curriculum
- Focused on skills, processes, and understanding
- Continuous, with diverse assessment

WALK–THROUGH OF MOUNTAIN VIEW MIDDLE SCHOOL

Welcome to Mountain View Middle School! You've been told that this school has a really great science program that serves *all* its students well. We want you to see for yourself. We hope you enjoy your time here.

1. On your way from the parking lot to the front door, you can't help but notice various clusters of kids and adults on the playground, on a grassy area, and walking along the sidewalk. What do you see that convinces you that science isn't only an in-the-classroom activity?

2. You walk in the door and you notice bulletin boards and displays on the walls along the corridors. What do you see that relates to science?

3. What do you notice that convinces you that they pay special attention to the wide diversity of their student population?

4. You are greeted by the principal who takes you to meet the seventh grade team, who are in a team meeting for the first hour of the morning. They are laying out next week's activities for their group of 100 students. What are some things you observe that relate to the science learning of their students?

5. What specific things do you observe that make you think they're working hard on their goal of "science for all?" What differences are they paying special attention to and in what ways?

6. Hallie Jeffers, the team leader, tells you that they do a lot of science; but not the typical textbook kind. She draws and explains a teaching/learning model that illustrates a general sequence they follow in most of their units. What are some of its elements or components or phrases?

7. Dwayne Hunter is working with a group of students who are exploring landfills, particularly decomposition. He tells you his teaching has been transformed since he went to a workshop and learned about constructivism: that he could no longer expect kids to learn from him telling them, but rather that they have to build their own understanding through multiple experiences and challenges to their current thinking. How do you observe this idea reflected in his teaching?

8. How do Dwayne's interactions with his students suggest his commitment to reaching *all* students?

WALK-THROUGH OF MOUNTAIN VIEW MIDDLE SCHOOL (continued)

9. Sara White is working with an excited group of students on a water pollution unit. You remember learning "the water cycle" in school, and having to memorize a lot of terms, but she tells you she's using the kids' natural interest in the environment to help them grapple with some "big ideas" of science, like cycles, models, and patterns of change. What do you observe?

10. You've heard that the sixth grade team is focusing attention on developing new ways to assess student learning. Their team meeting is in this next hour so you join them. As they settle into their meeting, they are recalling the days when they used to rely on end-of-chapter tests that largely focused on vocabulary, and they all agree that they could never do *that* again. How have things changed?

11. Over the past week, each teacher has read a different article on classroom assessment for schools with diverse student populations and they are discussing what they've read in light of upcoming report cards. What are some changes they are considering in reporting student learning?

12. In Room 14, groups of Arnie Patton's eighth graders are sharing the results of their investigation of a widely held belief that water from the drinking fountain on the third floor of the building is superior to the first and second floor fountains. What are some things you see and hear?

13. On your way out of the building you stop to thank the principal and she asks if you would take a few more minutes to see the science supply closet. What do you see, what does she say about how teachers get materials when they need them?

14. "How," you wonder out loud, "do the teachers stay up-to-date on teaching science?" What does the principal tell you?

SCIENCE THAT SUPPORTS EMERGING NATIONAL STANDARDS IS:

A curriculum for **ALL** students characterized by:

- a constructivist approach (continuous construction and modification of personal meaning)
- a balance of life, earth, and physical sciences
- fewer topics in-depth
- equitable access for all
- respect for diversity
- thematic, holistic concepts
- science as a human endeavor
- science content integrated with other content areas and with appropriate technology
- real-world problem solving
- accommodation of different learning styles, cognitive development, and psychological growth
- integration of values of different cultures, classes, races, and genders

An **activity-based curriculum** characterized by:

- engaging, hands-on, minds-on activities
- students doing real science, experiential learning
- cooperative learning communities
- students hypothesizing, observing, predicting, experimenting, and validating
- the use of scientific approaches in experimental design
- inductive reasoning
- open-ended projects and problems
- teachers that orchestrate and facilitate learning experiences
- student-generated research projects

Focused on skills, processes, and understanding characterized by:

- honing of laboratory, inquiry, and investigative skills
- making connections
- logical reasoning
- focused questioning strategies
- understanding and sense making
- multiple approaches to problem solving
- opportunities to formulate, test, and apply theories
- positive habits of mind

SCIENCE THAT SUPPORTS EMERGING NATIONAL STANDARDS IS: (continued)

Continuous, diverse assessment characterized by:

- integration with instruction
- alignment with instruction, standards, and curriculum guides and frameworks
- multiple sources of assessment data
- appropriate tasks and instructional formats
- personal reflection combined with peer feedback and teacher perceptions
- a focus on student understanding and learning
- methods and approaches that portray what society values
- performance on real-world tasks and projects

4

WHAT IS EFFECTIVE MATHEMATICS EDUCATION?

Audience:

- Individuals responsible for reform in mathematics education.

Desired Outcomes for Participants:

- To describe and illustrate national standards for learning and teaching mathematics.
- To identify and analyze the characteristics of effective mathematics education.
- To understand the attributes of an effective mathematics lesson.

Facilitator's Notes:

This activity introduces participants to mathematics education based on the current vision of effective mathematics teaching and learning recommended by the National Council of Teachers of Mathematics (NCTM) in the *Curriculum and Evaluation Standards for School Mathematics* (1989), the *Professional Standards for Teaching Mathematics* (1991), and the assessment standards, which are forthcoming (three separate but complementary publications).

There are six exercises in this activity. The first is designed to familiarize participants with the NCTM Standards and a new vision of mathematics teaching and learning. Participants take part in a "scavenger hunt" through the NCTM Standards, brainstorm principles of effective teaching and learning, and construct a set of characteristics for model lessons.

The next four exercises are model lessons that give participants interactive, hands-on experiences to bring the NCTM Standards to life. They are:

- *Collecting and Interpreting Data* (4-19)
- *Could You See Your Neighbor?* (4-25)
- *The Animal House Contest* (4-24)
- *Logic Problems* (4-43)

Each model lesson features a list of student learning outcomes. We have referenced these outcomes to not only the NCTM Standards but to science standards documents as well. Two science documents, whose full citations are listed in the **Additional References** for **Activity 3: What Is Effective Science Education?** are:

- *The National Science Education Standards*, November 1994 draft (NRC); and

- *Benchmarks for Science Literacy*, 1993 (Benchmarks).

The last exercise, *Analysis of Model Lessons and Deepening Understanding*, is designed to deepen understanding of the standards and their implications for systemic change.

Making choices about which model lesson to use will depend on the audience. For instance, a group of community members without much experience in schools but whose support is needed to change mathematics teaching might benefit from the lesson on collecting and interpreting data, which would give them a more extensive look at a variety of mathematics applications experienced in a cooperative setting.

When presenting the model lessons, it is important to stress that when they are used with students, they are part of a longer learning sequence that results in the outcomes indicated. None of the lessons is meant to stand alone. Participants should always discuss how such a lesson would be placed in a curriculum and for what purpose. Only then is the idea of an effective mathematics "program" modeled.

An additional exercise, but by no means a substitute for actually *doing* mathematics, is to use the "Good Morning, Miss Toliver" video referenced in the **Materials** section of Activity 4-1. This video depicts a teacher illustrating many of the principles and strategies from the NCTM Standards, including problem solving, communication, reasoning, patterns and relations, and mathematical connections. The students are involved in active, hands-on activities that are presented in a real world setting. After viewing the video, participants could analyze the strategies used by the teacher and identify elements they consider good mathematics instruction. This could be accomplished in approximately 45 minutes.

Note that not everyone will agree with all the strategies and behaviors depicted in the videotape. For example, Miss Toliver has a very dramatic style that will not be possible or appropriate for all teachers.

Additional References:

Curry, Brian and Tierney Temple. 1992. *Using Curriculum Frameworks for Systemic Reform*. Alexandria, VA: Association for Supervision and Curriculum Development.

Gann, Jeanette H. and Susan N. Friel. January 1993. "Implementing the Professional Standards for Teaching Mathematics: Making Change in Schools," *Arithmetic Teacher* 40 (5): 286-289.

Kober, Nancy. 1991. *EDTALK: What We Know About Mathematics Teaching and Learning*. Washington, DC: Council for Educational Development and Research.

Laboratory Network Program. January 1995. *A Toolkit for Professional Developers: Alternative Assessment*. Portland, OR: Northwest Regional Educational Laboratory.

Mathematical Sciences Education Board. 1989. *Everybody Counts: A Report to the Nation on the Future of Mathematics Education*. Washington, DC: National Academy Press.

National Commission on Excellence in Education. 1983. *A Nation At Risk: The Imperative for Educational Reform*. Washington, DC: U.S. Department of Education.

National Council of Teachers of Mathematics. 1989. *Curriculum and Evaluation Standards for School Mathematics*. Reston, VA: National Council of Teachers of Mathematics.

______________. 1991. *Professional Standards for Teaching Mathematics*. Reston, VA: National Council of Teachers of Mathematics.

Russell, Susan Jo and Rebecca B. Corwin. 1989. *Statistics: The Shape of the Data*. Palo Alto, CA: Dale Seymour Publications.

North Central Regional Educational Laboratory. 1991. *Schools That Work, The Research Advantage: Guidebook 2, Children as Problem Solvers*. Oak Brook, IL: North Central Regional Educational Laboratory.

Willoughby, Steven S. 1990. *Mathematics Education for a Changing World*. Alexandria, VA: Association for Supervision and Curriculum Development.

4-1 STANDARDS FOR LEARNING AND TEACHING MATHEMATICS

Materials:

- **Transparencies:**
  - *The NCTM Standards* (4-9)
  - *Carousel Brainstorming: Effective Teaching and Learning* (4-10)
  - *Mathematics That Supports the Standards Is:* (4-11)

- **Handouts:**
  - *NCTM Standards Scavenger Hunt* (4-12 through 4-15)
  - *Mathematics That Support the Standards Is:* (4-16 and 4-17)

- Multiple copies of the book, *Curriculum and Evaluation Standards for School Mathematics*. Reston, VA: National Council of Teachers of Mathematics, 1989.

- Overhead projector, screen, blank transparencies, and overhead pens

- Newsprint, easels, tape, and markers

- Index cards (5" X 8"), blank paper, and pens or pencils

- VCR, monitor, and video, "Good Morning, Miss Toliver" (1993) available from:
  FASE Productions
  PO Box 847
  Los Angeles, CA 90078
  800-888-0600
  $14.95 plus $5.00 shipping and handling

Time Required: One to two hours

Process:

1. Introduce the exercise by saying that it will focus on effective mathematics education through an exploration of the NCTM Standards and model mathematics lesson(s). If participants are unfamiliar with the NCTM Standards, or would benefit from a refresher, use the following scavenger hunt.

NCTM STANDARDS SCAVENGER HUNT

2. Explain that national professional organizations have developed standards for mathematics education that participants will now have a chance to explore. Ask them to work in groups of three or four. Each person should select a grade level to focus on for this exercise. It is not necessary for all members of the group to focus on the same grade. Hand out one copy of the *Curriculum and Evaluation Standards for School Mathematics* to each group (or participant if there are enough books) and one copy of the handout **NCTM Standards Scavenger Hunt (4-12 through 4-15)** to each participant.

   Each group is to use the publication to answer all of the questions on the handout. You may want to suggest that the questions be divided among group members, with individuals working on their own and then reporting back to the whole group. Allow 30 minutes.

   With the whole group, review a few of the key scavenger hunt questions. Then use the **NCTM Standards (4-9)** transparency to summarize the emphasis of the Standards.

CAROUSEL BRAINSTORMING: WHAT IS EFFECTIVE TEACHING AND LEARNING?

3. Next, use carousel brainstorming to answer four (or more) questions about effective teaching and learning. Refer to **Appendix B-2** to provide instructions for carousel brainstorming.

   Place the **Carousel Brainstorming: Effective Teaching and Learning (4-10)** transparency on the overhead and review the four questions that are also on newsprint around the room. Each group will respond to each question as they rotate around the room. Allow 30 minutes.

   The questions for carousel brainstorming are:

   - What are some principles for designing an effective climate for learning?
   - What factors influence whether or not people learn mathematics?
   - What can educators do to enhance the learning of mathematics?

- What changes in instruction will promote better learning of mathematics?

4. Summarize Steps 2 and 3 for the whole group by using the **Mathematics That Supports the Standards Is: (4-11)** transparency and the handout of the same title **(4-16 and 4-17)**.

CHARACTERISTICS OF A MODEL LESSON

5. In order to develop participant understanding of what constitutes a model lesson, lead the group through a consensus-building process called the workshop method or card technique. The "storyboarding" type process uses 5" X 8" cards to collect and display the brainstormed data generated by the group.

   For the card technique, you will need plenty of blank index cards, markers, and tape.

   Tell the group that they will now explore the attributes of a model lesson. Ask participants to share the contexts in which they have used or might use a model classroom lesson to demonstrate the "spirit" of the NCTM Standards.

   On newsprint or a blank transparency write, "What Are the Characteristics of a Model Lesson?"

   Ask each participant to think of some responses to the question and give them three to five minutes to jot down their ideas on a piece of paper. Have them select the three they consider to be the most significant.

   Have them form small groups of three or four. Ask them to share their individual ideas in their groups, come to consensus on five or six ideas (from among those contributed by each member), and write each idea on a separate index card. Encourage them to state their ideas concisely, in three to five words.

   Place eight to ten blank index cards (or cards with a generic symbol) across a blank wall. (These constitute unnamed categories.) Ask each group to pass forward one of their cards.

   Attach cards to the wall with tape, one at a time. Ask for clarification if the idea on the card is not understandable. Ask group members to help cluster the cards into categories of similar ideas. They may suggest adding new clusters, combining two or more columns into one, and/or moving index cards representing various ideas around from one cluster to another.

Ask the groups to pass forward another card, and, again, place the cards one at a time in the cluster as appropriate. For the third "round," ask each group to have one person go to the wall and place the remaining card in the clusters they believe are most appropriate, or make a new cluster.

Ask the group to check any ideas describing characteristics of a model lesson. Ask: Is there anything missing?

Ask the group to name each column. (The names can be written on the blank index or symbol cards taped to the wall first.)

Summarize or read the columns and ask the group to reflect on the entire set of characteristics.

INTRODUCING THE MODEL LESSON

6. Before beginning the model lesson you have chosen, ask the group to think about the question: There is a national effort underway to change the way mathematics is taught in our schools; why do we need a change in mathematics instruction? After a minute or two of "think time," list responses on a clear transparency or chart.

   Note: This process step can be skipped if the NCTM scavenger hunt or Carousel Brainstorming technique was used.

7. Tell participants that they are going to take part in a lesson designed to model the kind of instruction advocated by the NCTM Standards.

   Introduce the model lesson you have chosen for this session.

THE NCTM STANDARDS

- Mathematics as problem solving
- Mathematics as communication
- Mathematics as reasoning
- Number and number relations
- Whole number computation
- Patterns and relations
- Mathematics as connections
- Geometry
- Measurement
- Data collection
- Probability

CAROUSEL BRAINSTORMING: EFFECTIVE TEACHING AND LEARNING

- What are some principles for designing an effective climate for learning?

- What factors influence whether or not people learn mathematics?

- What can educators do to enhance the learning of mathematics?

- What changes in instruction will promote better learning of mathematics?

Mathematics that supports the STANDARDS is:

- A curriculum for ALL students
- A problem-solving activity based curriculum
- An active, constructive process
- Focused on developing mathematical power
- Continuous, with diverse assessments

NCTM STANDARDS SCAVENGER HUNT

1. What are the assumptions governing the selection and shaping of the curriculum standards at your grade level?

2. Name two topics that are to receive increased attention at your grade level.

3. Name two topics that are to receive decreased attention at your grade level.

4. Name the one topic that is to receive increased or decreased attention that you agree or disagree with most and explain why.

NCTM STANDARDS SCAVENGER HUNT (continued)

5. How many curriculum standards are there at your grade level?

6. What four standards are common to all the grade levels?

7. What is the focus of Curriculum Standard 7 at your grade level?

8. What is one thing that you learned from reading the discussion for Curriculum Standard 10 at your grade level?

NCTM STANDARDS SCAVENGER HUNT (continued)

9. What are the names of the three sections of the Evaluation Standards?

10. What is meant by "alignment" in Evaluation Standard 1?

11. What are the five purposes of assessment given in Table 3.1 (p. 200)?

12. According to Evaluation Standard 9, what does knowledge of mathematics procedures involve?

NCTM STANDARDS SCAVENGER HUNT (continued)

13. In which of the indicators for program evaluation (Evaluation Standard 11) is parent involvement specifically mentioned?

14. In Evaluation Standard 13, what does "opportunity to learn" mean?

MATHEMATICS THAT SUPPORTS THE STANDARDS IS:

A curriculum for **ALL** students characterized by:

- worthwhile, challenging problems
- emphasis on exploring ideas
- development and revision of models based on prior knowledge and new data
- integration of content within mathematics with other content areas, and with appropriate technology

A **problem-based curriculum** characterized by:

- process permeating the entire curriculum that provides the context for learning concepts and skills
- problem situations that arise from everyday experiences
- enhancement of students' communication and reasoning abilities
- use of thought-provoking questions, speculations, investigations, and explorations

An **active, constructive process** characterized by:

- problem solving
- communicating
- reasoning mathematically
- making connections
- finding, revising, and evaluating models
- validating and/or asking new questions
- developing learning communities
- using cooperative learning
- teacher as facilitator of learning

Continuous, diverse assessment characterized by:

- integration with instruction, learning, and programs
- alignment with instruction, standards, and curriculum guides and frameworks
- application to improving instruction, learning, and programs
- multiple sources of assessment data
- appropriate tasks and instructional formats
- personal reflection combined with peer feedback and teacher perceptions
- a focus on student understanding and learning
- performance on real-world tasks and projects

MATHEMATICS THAT SUPPORTS THE STANDARDS IS: (continued)

Focused on developing mathematical power characterized by:

- solid understanding of mathematical ideas
- positive attitudes toward mathematics
- confidence in one's own ability
- flexibility of thought and approach to problem solving
- willingness to explore new questions and horizons
- use of appropriate technology.

4-2 MATHEMATICS MODEL LESSON — COLLECTING AND INTERPRETING DATA

Desired Outcomes for Participants:

- To illustrate, through actual participation, the elements of an exemplary mathematics learning experience.
- To demonstrate how, through a well structured problem solving activity, students can learn to sort, classify, graph, and analyze data.

Student Learning Outcomes from National Mathematics and Science Standards:

The learner will:

- use pictographs and graphic representations to model problems (NCTM, 75);
- collect, organize, and describe data; construct, read, and interpret displays of data (NCTM, 54; NRC, V-74);
- determine the reasonableness of results through estimation (NCTM, 36);
- understand basic characteristics of measures of central tendency (e.g., mean, median, mode) (NCTM, 171);
- make and use measurement in problem and everyday situations (NCTM, 51);
- use appropriate tools and techniques to gather, analyze, and interpret data (NRC, V-74);
- understand that scientists can have different explanations for the same set of observations, but all scientists expect explanations to be logical arguments backed up by evidence (Benchmarks, 11);
- understand that science experiments normally have reproducible results: science experiments generally work the same way in different places (Benchmarks, 6); and
- clarify problems using discussions with peers (NCTM, 75).

Source: This activity was adapted with permission of *Arithmetic Teacher* from "IDEAS" by Carne S. Barnett and Sharon L. Young. ©1991, 26-33.

Materials:

- **Transparency:**
  - *Sneaker Tread Prints* (4-24)
- Overhead projector, screen, blank transparencies, and overhead pens
- Newsprint, tape, and markers
- Light-weight paper and dark crayons
- Two paper strips for creating graphing axes – approximately 1.5 meters long each
- A 20-centimeter length of string, a meter stick or tape, and a pair of scissors for each two participants
- Double-sided tape (or tape rolled to attach prints to graph and allow repositioning)

Time Required: One to one and one-half hours

Facilitator's Notes: This model lesson encourages participants to apply mathematical processes to a physical characteristic – shoe treads. Data are collected, classified, and categorized. Hypotheses are proposed, along with plans to test them. Comparisons are made to demonstrate a real-world application of mathematics – that of determining one's relationship to a group and to individuals within the group. Skills used in this activity include: sorting, comparing data, designing investigations, defending points of view, and making graphs.

Process:

1. Prior to the lesson, apply the paper strips to the wall or a bulletin board so that the two axes of a bar graph are formed (see Step 5). Do not label axes.

2. Introduce the lesson by having participants survey the room and identify various types of footwear worn by members of the group.

   Then ask participants to form groups of ten and use paper and crayons to make rubbings of the sole of one of each of their shoes. (To make a rubbing, place paper on the sole of one shoe and rub vigorously with the edge of a crayon to get a "print" of the shoe's sole.) After rubbings are complete, have participants cut out the sole outlines and sort those of their group into categories.

Have each group display on newsprint their categorization of prints (using double-sided tape) and record the criteria used to sort the prints. Then have the group decide on a different way to sort the prints and record on another piece of newsprint. After they have sorted another way, ask groups to record all other categories they can think of to sort the prints. Allow 30 minutes.

Ask groups to report out; list the criteria used by the groups on an overhead transparency or newsprint to illustrate the different ways of grouping the data.

Note: Participants may focus on such attributes as geometric designs, words, left-right patterns, the placement of designs, or styles of shoes.

3. Have each group of ten divide into two groups of five. Ask the groups of five to speculate as to why certain designs might be used on the soles of shoes. Allow 15 minutes.

   Ask each group of five to share two ideas. Write ideas on overhead or newsprint. Ask how their ideas might be tested.

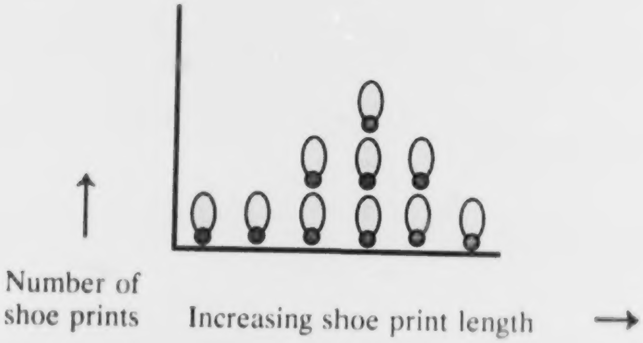
   (If participants do not have on a variety of footwear, use the **Sneaker Tread Prints (4-24)** transparency to stimulate discussion of various sole treatments.)

   Here are some responses you might get:

   Walking shoes or tennis shoes need less traction than running shoes and the texture of the sole is different for these shoes. Some shoes have crease lines on the ball of the foot to ease walking and some shoes have a circular shape where the joint of the big toe fits in the shoe. These designs may indicate that a different material is used in this spot to furnish extra padding. Shoes having tread prints with basically horizontal patterns are usually used for running and walking because the foot is typically going in one direction and a horizontal pattern gives appropriate traction. Shoes with tread prints having more complex patterns are usually used for sporting activities in which the foot must change direction.

4. Have participants estimate the length of their shoe print to the nearest centimeter and then check their estimate by using a measuring stick or tape. Have them record this number (with measurement unit) directly on the shoe print (see Step 2).

5. One at a time, have participants place their prints vertically on the horizontal axis of the graph you have previously constructed (Step 1). They should arrange their prints (vertically) in relation to the length of other prints already on the graph. Shoes which are the same length should be placed above each other (heel to toe). As more participants add their prints, it may be necessary to make adjustments to the placement of individual prints. Allow 15 minutes.



6. When everyone has placed his or her shoe print on the graph, ask participants to draw conclusions about the data. Ask them to decide how to label the graph in order to communicate more information about the data (see sketch above).

   Note: In discussing the data, participants will probably point out that some print lengths seem to occur more often than others.

7. Ask participants to determine if their print is shorter than, longer than, or about the same as the average size of the group. Ask how this fits with their perception of "average." Discuss mean, median, and mode in describing measures of central tendency, and bring up the concept of "average" as it relates to the whole group or population.

   Mean – a particular kind of "middle" or balancing point in a collection of data. Every value is exactly balanced by another value; the mean is the balance point where the total differences above the mean equal the total differences below the mean.

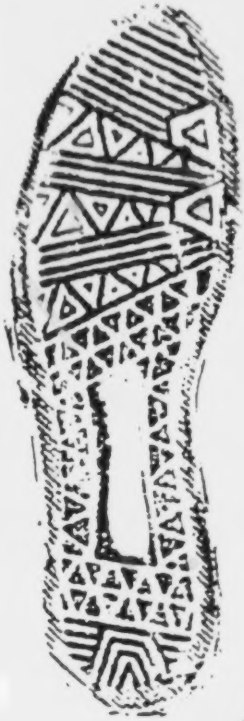
   Median – a measure of center. Half of the data are less than or equal to the median value; half the data are equal to or greater than the median value. Other features, including the range of the data and the way they are clustered or spread out, provide a context for understanding the median.

Mode – the most frequent value in a data set. Data sets that contain categorical data (types of pets, foods, transportation) can be used as a basis for comparing categories – "more people like chocolate than vanilla ice cream."

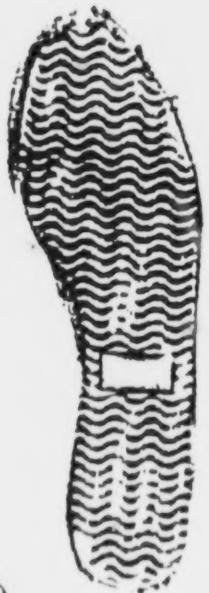
Ask participants if they think the same results would be obtained if they were to survey a larger segment of the population. A smaller segment? Assuming a bell represented the population distribution, what factors may have skewed this particular group's results?

8. Go to **Activity 4-6: Analysis of Model Lessons and Deepening Understanding** on page 4-49 to debrief the lesson.

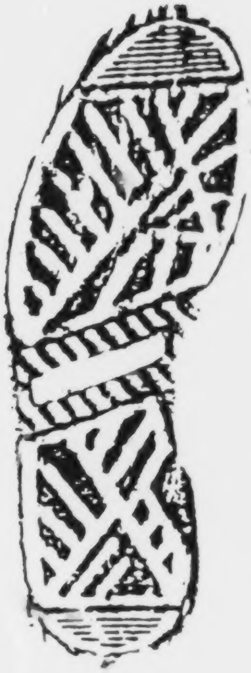
SNEAKER TREAD PRINTS



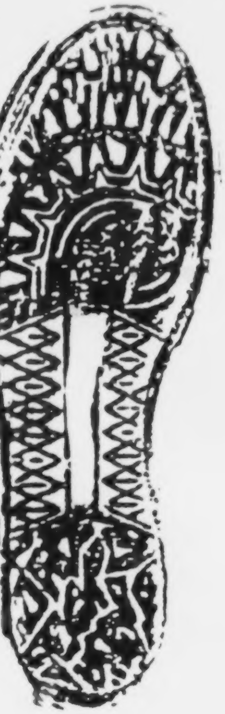
A



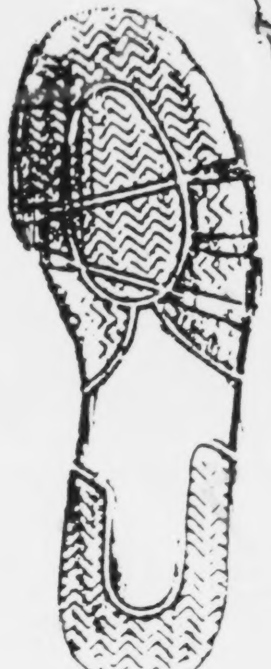
B



C



D



E

4-3 MATHEMATICS MODEL LESSON — COULD YOU SEE YOUR NEIGHBOR?

Desired Outcomes for Participants:

- To illustrate, through actual participation, the elements of an exemplary mathematics learning experience.
- To demonstrate how, through a well structured problem solving activity, students can learn to evaluate the validity of a hypothesis based on data collection and measurement.

Student Learning Outcomes from National Mathematics and Science Standards:

The learner will:

- make effective use of ruler for making measurements (NCTM, 51; NRC, V-74);
- articulate similarities and differences between basic problem solving strategies (NCTM, 23);
- work with a team to solve problems and share findings with others (Benchmarks, 15; NCTM, 75); and
- understand that clear communication is an essential part of doing science and mathematics (Benchmarks, 16).

Materials:

- Newsprint, easels, tape, and markers
- Assembled on a table:
  - almanacs
  - atlases
  - calculators
  - state maps
  - rulers
  - scissors
  - string or crochet cotton

Source: This activity was adapted with permission of Shirley Hill, University of Missouri, Kansas City, Missouri, n.d.

Time Required: One to one and one-half hours

Facilitator's Notes: This model lesson encourages participants to apply mathematical concepts including hypothesizing, problem solving, measurement, and data collection to solve a hypothetical problem.

Process:

1. Assemble the materials on a table at the front or rear of the room.

2. Introduce the lesson by relating the following scenario:

   The governor of (your state) has just proclaimed it to be "State Border Appreciation Day." The event planned for this day is to form a human state border. Each resident of (your state) is to proceed to the nearest state border to become a part of the living boundary.

3. Ask the following questions and ask participants to raise hands; record the responses on newsprint in columns labeled yes and no.

   If all the residents of your state lined up along the border, would the people standing next to each other be able to:

   - stand shoulder-to-shoulder?
   - hold hands?
   - touch fingertip-to-fingertip?
   - hold a conversation in a normal tone of voice?
   - see each other?

4. Ask what information they would need to obtain in order to determine how far apart residents in their state would be standing. Record the responses on newsprint and display.

   Note: It may be useful to know that 5,280 feet = 1 mile.

5. Discuss definitions. For instance, if the state has barrier islands or keys, what constitutes a state boundary? The group's definitions should be recorded on newsprint and displayed.

   Ask participants to hypothesize how far apart the state residents would be standing if they were to form a human border.

6. Divide participants into groups of four. Tell them that all the information needed to determine how far apart the state's residents would be standing can be found using the items on the materials table. Allow 30 to 45 minutes to arrive at a solution. Each group should be prepared to defend its answer by describing the numbers and process used to arrive at it.

   Explain to participants that each group should determine how to solve the problem. If a group seems to be having a hard time starting the solution process, you may hint at one or more of the following:

   - population data are found in the almanac,
   - the mileage scale can be found on a state map, and
   - string can be used to measure irregular boundaries.

7. Ask the groups to report out. Since they will use different processes and different methods of estimating, they will arrive at slightly different answers. Answers that are very different may be suspect – perhaps that group may wish to re-figure to self-determine its error.

   Discuss reasons for the variety of solutions. Ask why it is helpful to share solution strategies with the entire group. (One answer: To refine the process for use in the future on similar problems.)

8. Ask participants in which states they think the people would be standing closer together than in their state. In which states would the residents be standing farther apart? Why? How do they know?

9. Go to **Activity 4-6: Analysis of Model Lessons and Deepening Understanding** on page 4-49 to debrief the lesson.

4-4 MATHEMATICS MODEL LESSON — THE ANIMAL HOUSE CONTEST

Desired Outcomes for Participants:

- To illustrate, through actual participation, the elements of an exemplary mathematics learning experience.
- To demonstrate how, through a well-structured prolem solving activity, students can learn to explore plane and solid geometry using a variety of manipulative materials.

Student Learning Outcomes from National Mathematics and Science Standards:

The student will:

- understand the basic characteristics of the concept of three dimensions (NCTM, 48);
- analyze the effects of combining, subdividing, and changing shapes (NCTM, 48);
- understand the similarities and differences between a trapezoid, rhombus, and quadrilateral (NCTM, 48);
- communicate a problem, design, and solution; design a solution or product (NRC, V-38; NRC, V-93); and
- clarify problems using discussions with peers (NCTM, 75).

Materials:

- **Transparency:**
  - *Animal House Contest* (4-34)
- **Handouts:**
  - *Sorting, Classifying, Naming, and Describing Wooden Geometric Solids* (4-35)
  - *Describing Polyhedra* (4-36)
  - *Animal House Contest* (4-37)
  - *Recording/Evaluation Sheet* (4-38 through 4-40)
  - *The Straw Clubhouse: Introduction* (4-41)

Source: This activity was adapted with permission of the authors from materials created by Cathy Cook and Claudette Rasmussen, North Central Regional Educational Laboratory, n.d.

- **Sets of materials (for groups of three):**
  - polydrons and/or wooden blocks
  - toothpicks or small straws
  - mini-marshmallows or gum drops
  - drinking straws
  - scissors and masking tape
- Overhead projector, screen, and pens or pencils

Time Required: One and one-half hours

Facilitator's Notes: In this model lesson, participants solve a real-life, open-ended problem in a lesson designed to be used with primary students. There is another scenario included at the end of the lesson for adapting the lesson for older students. The lesson reinforces all aspects of the NCTM Standard for geometry and spacial sense, providing practice in identifying, exploring, and using three-dimensional shapes for a real purpose. Further, the lesson integrates the mathematics content with interdisciplinary problem solving, critical thinking and reasoning, cooperative learning, and alternative assessment.

This lesson begins with exploration and classification of three dimensional wooden blocks. This is followed by *The Animal House Contest*, an open-ended, problem-solving lesson that uses manipulative materials to simulate a real-life approach. The academic foci of the lesson are:

- content topic: geometry, especially three-dimensional shapes, and linking two-dimensional to three-dimensional figures
- critical thinking phase(s): introduction to the thinking phases
- problem solving strategy and lesson type: open-ended, real-life
- social/collaborative focus: contributing ideas and taking turns.

Process: 1. Explain to the participants that they will be engaged in a lesson designed as a contest for primary-aged students. The contest involves using geometric shapes to construct buildings. To introduce the lesson, they will spend a few minutes working with shapes.

Ask participants to form groups of three. Give each group a set of wooden three-dimensional figures and copies of the handout **Sorting, Classifying, Naming, and Describing Wooden Geometric Solids (4-35)**. Ask them to sort the figures into groups, and to name and describe each group either orally or by using the chart. Distribute the handout **Describing Polyhedra (4-36)** and note that with older students, the term "polyhedron" could be introduced as a solid with all flat surfaces and that the term "vertices" refers to the points that terminate a line. Students might then use this second chart to describe particular polyhedra they have in their sets.

2. Introduce the contest to the whole group by saying that today they will work in groups of three to solve a three-dimensional (or solid) geometry problem. Mention that the social skills usually taught with this lesson include encouraging everyone to contribute ideas, take turns, and sit "knee to knee."

   Place the **Animal House Contest (4-34)** transparency on the overhead projector and cover all of the text but the title. Pose question 1 (see below) to the group. Uncover and read the first paragraph and pose questions 2 through 5. Uncover the second paragraph (the contest rules) and pose questions 6 through 8. Finally, uncover the remaining transparency and pose the problem task at the bottom.

   1. What do you think this problem (animal house contest) is about?
   2. What kinds of animals need a house?
   3. Have you ever entered a contest before? What was it like?
   4. What is a three-dimensional figure?
   5. What are some solid figures we've been discussing in math class?
   6. What solid figure uses squares and rectangles in its construction?
   7. What usually happens in a contest?
   8. What is it that we don't know about the contest yet?

3. Before the participants begin the task, summarize the task by touching on and asking the following questions:

- How might you restate the contest rules for building the animal house?
- Why is it important to follow contest rules?
- How might each group build the animal houses a little bit differently?
- What materials would be good to use to model our animal house?

4. Distribute the handouts **Animal House Contest (4-47)** and **Recording/Evaluation Sheet (4-38 through 4-40)** to each group. Give the next set of directions as follows.

   They will be working in groups of three to come up with a suitable design that follows the contest rules. They will first use polydron manipulatives to plan their design before using toothpicks (or small straws) and mini-marshmallows (or gum drops) to make their model. Within each group there will be a contractor, an architect, and a building inspector. The **contractor** will get supplies and flip the phase cards. The **architect** will record what the group plans to do before they begin the animal house. The **building inspector** will make sure that everyone has a chance to give (or show) an idea for the animal house and will be the recorder of the group's evaluation.

   Everyone in the group will check the animal house against the plan as it is under construction. Explain that you will be circulating and looking for groups that are sitting "knee to knee" and taking turns when building the animal house. At the end of the lesson they will be asked to evaluate how well their group contributed ideas, took turns, and sat "knee to knee," as well as how they used the thinking phases.

   Refer participants to the handout **Recording/Evaluation Sheet (4-38 through 4-40)** and have the groups answer the questions on the first page.

5. Point to the materials table and ask the groups to begin their construction. Allow 20 minutes for construction.

6. Ask groups to begin their small group evaluation. The **building inspector** should pose questions from the **Recording/ Evaluation Sheet** for group discussion.

7. Use these questions for debriefing with the whole group.

    - What shapes did your group use the most? Why do you think those shapes worked for your group?
    - How did encouraging each other to give ideas help you to be creative?
    - How did taking turns help you with this problem?
    - What would you do differently if you were to build a new animal house?

8. Distribute the handout **The Straw Clubhouse: Introduction (4-41)** for future reference. Note that this scenario could be used with older students in a similar lesson format.

9. Go to **Activity 4-6: Analysis of Model Lessons and Deepening Understanding** on page 4-49 to debrief the lesson.

ANIMAL HOUSE CONTEST

Frank Lloyd Wright was a famous architect who loved to build buildings using geometric shapes. He mainly used squares and rectangles to create the special three-dimensional designs. The Frank Lloyd Wright Association has issued a contest for your group. They would like you to design an animal house using geometric shapes.

The contest rules are: You must plan and create a three-dimensional house for any animal that you choose. The house must include two different shapes. For example: Frank Lloyd Wright used two shapes – squares and rectangles – that were put together to create rectangular solids.

You will be making a model using toothpicks for the edges of your figure and mini-marshmallows for your figure's vertices. Your design will be judged on whether or not you followed the contest rules.

How many different designs can we create as a whole group? How many different shapes might we include?

SORTING, CLASSIFYING, NAMING, AND DESCRIBING WOODEN GEOMETRIC SOLIDS

Small group member names:____

Solid Group Name	**Description of Group of Solids**

DESCRIBING POLYHEDRA

Names: ______________________________

____

____

____

Name and/or Describe Polyhedron	Name Faces in the Polyhedron	# of Faces	# of Vertices	# of Edges

ANIMAL HOUSE CONTEST

Frank Lloyd Wright was a famous architect who loved to build buildings using geometric shapes. He mainly used squares and rectangles to create the special three-dimensional designs. The Frank Lloyd Wright Association has issued a contest for your group. They would like you to design an animal house using geometric shapes.

The contest rules are as follow: You must plan and create a three-dimensional house for any animal that you choose. The house must include two different shapes. For example: Frank Lloyd Wright used two shapes – squares and rectangles – that were put together to create rectangular solids.

You will be making a model using toothpicks for the edges of your figure and mini-marshmallows for your figure's vertices. Your design will be judged on whether or not you followed the contest rules.

How many different designs can we create as a whole group? How many different shapes might we include?

RECORDING/EVALUATION SHEET

Jobs:

Architect: ______________________________(recorder of the group problem solving)

Building Inspector: _________________________ (checks for contributing ideas and records group evaluation)

Contractor: _________________________(materials supplier and phase card flipper)

Understanding:

The **Architect** reviews the rules with the group and asks the questions below, recording the responses.

Rules:

- Your team's task is to build an animal house model that is three-dimensional.
- Your model must be sturdy and stand alone.
- You must include, at least, two different shapes (triangle, square, rectangle, etc.).
- You may communicate within your team by any method.
- Each team will be given some toothpicks (or small straws) and mini-marshmallows (or gum drops) to build their animal house model.

1. What needs to be included in the animal house?

2. What is necessary in order for a model of a house to be "sturdy"?

3. Why will it be important to encourage each other to contribute ideas?

RECORDING/EVALUATION SHEET (continued)

Planning:

The **Architect** records what the group plans to do before they begin building the animal house.

- What animal will our group build a house for?
- What part of the house will we work on first?
- What shapes would be good to use in our model?
- How will we make sure that everyone contributes to the building of the model?

Carrying Out:

The **Contractor** passes out the toothpicks/small straws and mini-marshmallows/gum drops to the group. The animal house is built using the plan that was developed by the group.

As you work together, keep these questions in mind:

- How are we making sure that everyone has a chance to contribute to the design?
- How will we describe our design to other groups?
- How would our building be different if we used only two shapes?
- What other materials could we use to model our design?

RECORDING/EVALUATION SHEET (continued)

Looking Back:

The **Building Inspector** asks the questions and circles the group's responses on the rating form.

- How would our group rate the sturdiness of our animal house?

  GREAT GOOD FAIR NEED TO WORK ON IT

- How well did our group contribute ideas?

  GREAT GOOD FAIR NEED TO WORK ON IT

- How well did our group sit "knee to knee" when designing the animal house?

  GREAT GOOD FAIR NEED TO WORK ON IT

THE STRAW CLUBHOUSE: INTRODUCTION

> *When an object is created by design, we say that it was produced "on purpose." The designer has formed the object so that it performs as planned, i.e., "form follows function." In this sense, design surrounds us in every phase of experience – the clothes we wear, the dishes we prepare, the style of our conversation – as well as the products of the various arts. Architecture is the discipline that cultivates systematically the art of design for the creation of structures and their surroundings.*
>
> – Harry S. Broudy

Architecture is an art form that has a function. Although architects are trained as artists, they must also learn the disciplines of mathematics, science, and sociology as they prepare to practice their profession. Architects must plan buildings carefully so they are not only pleasing and interesting to look at, but are also safe, comfortable, and designed to fit the needs of the people who will live, work, shop, and study in them.

Problem: Imagine yourselves as members of an architectural team. You all have some artistic ability and have had experience using elements such as **line, shape, texture, color, space, repetition, balance** and **symmetry**, and to communicate a particular **image** through a structure. You also need to use your mathematical skills and understanding of geometric solid figures to plan how the building should be built so that it will be **safe** and **strong.** The materials you choose need to make the building **structurally sound** and hopefully enhance the design as well.

As a team your first project will be fun but also a challenge! You have been asked to build a community clubhouse. This clubhouse will be used by a variety of clubs in the area and must contain at least three separate rooms, each being a different shape. You have decided to begin by making a model of the construction of the clubhouse through the use of drinking straws, scissors, and masking tape.

How will you go about working together to complete this project?

Rules for Play:

- Your team's task is to build a "straw clubhouse" that is sturdy and attractive and uses at least three different solid figures.
- Each individual will be given some drinking straws, and each team will be given one roll of masking tape and a pair of scissors. These are the only materials that you may use in construction.
- You may communicate within your team in whatever way you wish.
- You will have approximately 15 minutes in which to complete this task.
- At the end of that time period, someone in your group should be prepared to explain why your team considers your "straw clubhouse" to be both sturdy and aesthetically pleasing, and be able to describe by name the solid figures that you used in your design.

4-5 MATHEMATICS MODEL LESSON — LOGIC PROBLEMS

Desired Outcomes for Participants:

- To illustrate, through actual participation, the elements of an exemplary mathematics learning experience.
- To demonstrate how, through a well structured problem solving activity, students can learn to use deduction and reasoning to solve logic problems.

Student Learning Outcomes from National Mathematics and Science Standards:

The student will:

- recognize and analyze alternative explanations and predictions; think critically and logically to make the relationships between evidence and explanations (NRC, V-74);
- recognize and apply deductive reasoning (NCTM, 81);
- attempt to verify solutions or results in situations where it is warranted (NCTM, 36); and
- clarify problems using discussions with peers (NCTM, 75).

Materials:

- **Handouts:**
  - *Logic Problems* (4-45 and 4-46)
  - *Answers to Logic Problems* (4-47)

Time Required: 45 minutes

Facilitator's Notes: According to the NCTM, learning to reason mathematically is an important goal of school mathematics and logic problems are one way teachers can strive to meet this goal. In this lesson, participants work together to solve three puzzle problems and share strategies for arriving at their solutions. After discussing their answers and methods, they work in their teams to write similar puzzles for other groups to solve.

Source: This activity was adapted with permission of Research for Better Schools from *Classroom Activities in Thinking Skills* by Janice Dilliplane-Kruse. ©1988.

Process:

1. Distribute the handout **Logic Problems (4-45 and 4-46)** to each participant. Ask participants to work in pairs to solve the first logic problem. They may use any method they like but should be able to explain how they arrived at their solution.

2. Next, have two pairs form a group of four to discuss their solutions and strategies.

   Note: If not everyone has arrived at a solution, this will give an opportunity for everyone to discuss the problem and have someone else's strategy explained in a non-threatening atmosphere. This also allows you to survey the room and provide clues or assistance for groups that may not have arrived at a solution.

3. Have a spokesperson report out their group's answer and solution strategy. Ask for other answers or strategies from other groups.

   Note: If no one used a matrix chart, you might introduce that as a possible tool in solving problems of this type.

4. Ask groups of four to find a solution for the second problem. Again have groups pair up to share their solutions and strategies.

5. Discuss answers and solution strategies with the whole group. If time permits, each group of four might then be asked to develop a problem of their own using people and identified characteristics from the session, or ask groups to solve the third problem. Allow about 15 minutes for this portion of the activity. At any point, if participants seem stuck at solving a problem, distribute the handout **Answers to Logic Problems (4-47)**.

6. Go to **Activity 4-6: Analysis of Model Lessons and Deepening Understanding** on page 4-49 to debrief the lesson.

LOGIC PROBLEMS

PROBLEM A

Mr. Black, Mr. Green, and Mr. Brown arrived at the restaurant at the same time. One was wearing a black tie. Another was wearing a green tie. The third was wearing a brown tie.

As they sat down to eat, the man wearing the green tie smiled. "Why are you smiling?" asked Mr. Black. "Look at the colors of our ties," he answered. "Each color is the same as one of our last names. But no one is wearing a tie that matches his own name."

WHAT WAS THE COLOR OF THE TIE THAT EACH MAN WAS WEARING?

PROBLEM B

Joan needs a pair of ski socks and knows that there are six pairs in a box in the attic, all her size.

"They are all white," said her mother. "But two pairs have red borders, two pairs green borders, and two pairs blue borders. Make sure you get a matching pair."

The attic is completely dark so Joan can't see the colors of the borders.

HOW MANY SOCKS MUST SHE TAKE OUT OF THE BOX BEFORE SHE CAN BE SURE THAT SHE HAS ONE MATCHING PAIR?

LOGIC PROBLEMS (continued)

PROBLEM C

Six women sat around a circular table. Their names were Ms. Able, Ms. Bates, Ms. Cain, Ms. Dodd, Ms. Gray, and Ms. Hill.

One woman was very young, one was clever, one was tall, one was blond, one was a millionaire, and one was a singer.

The millionaire sat directly opposite Ms. Gray. The woman who was tall sat opposite Ms. Bates, who sat between the clever women and the millionaire. The young woman sat opposite Ms. Cain, next to the tall woman and to the left of the millionaire. Ms. Able sat to the left of the young woman and opposite the singer. Ms. Hill sat opposite Ms. Cain.

IDENTIFY EACH OF THESE WOMEN BY NAME AND DESCRIPTION.

ANSWERS TO LOGIC PROBLEMS

WHAT WAS THE COLOR OF THE TIE THAT EACH MAN WAS WEARING?

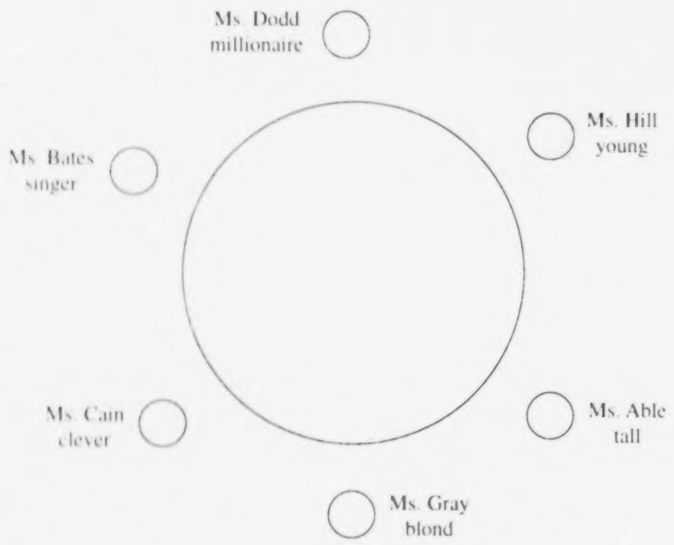
ANSWER TO PROBLEM A: Mr. Black spoke to the man wearing a green tie, therefore he is not wearing green nor black. Mr. Black must be wearing the brown tie. Mr. Green is wearing the black tie. Mr. Brown is wearing the green tie.

HOW MANY SOCKS MUST SHE TAKE OUT OF THE BOX BEFORE SHE CAN BE SURE THAT SHE HAS ONE MATCHING PAIR?

ANSWER TO PROBLEM B: Four. If the first three socks are all different, the fourth sock must match one of the first three. Only by luck would she have a matching pair by taking out less than four socks.

IDENTIFY EACH OF THESE WOMEN BY NAME AND DESCRIPTION.

ANSWER TO PROBLEM C: Ms. Able is tall. Ms. Bates is the singer. Ms. Cain is clever. Ms. Dodd is a millionaire. Ms. Gray is blond. Ms. Hill is young.



4-6 ANALYSIS OF MODEL LESSONS AND DEEPENING UNDERSTANDING

Desired Outcomes for Participants:

- To connect the outcomes of the model lessons with national standards for mathematics education.
- To develop specific recommendations for change in mathematics education.

Materials:

- **Transparencies:**
  - *The NCTM Standards* (4-9)
  - *Mathematics That Supports the Standards Is:* (4-11)
- **Handouts:**
  - *EDTALK Sections* (4-52 through 4-58)
- Overhead projector and screen
- Newsprint, tape, and markers

Time Required: One and one-half hours

Facilitator's Notes: After using Process Steps 1 and 2 to debrief the model lesson, you may wish to further understanding of additional elements of mathematics education through study (in jigsaw fashion) of a recent synthesis of research. Afterwards, for participants who have experienced **Activity 1: Framing the Dialogue Around Systemic Change** of the *Toolkit*, you can link the lesson just completed to the idea of systemic change.

Process: DEBRIEFING THE MODEL LESSON

1. After completion of the model lesson, show **The NCTM Standards (4-9)** transparency and review them with the group. Ask participants to work in groups of three or four to come up with specific examples of how the mathematics lesson exemplifies the standards. Have each group report out one example.

2. Show the **Mathematics That Supports the Standards Is: (4-11)** transparency and lead the group in a discussion about the elements on the transparency.

   Note: Stress the interrelationship of the key elements: the inclusion of all students, the active construction of knowledge, a problem-solving, activity-based curriculum, development of mathematical power, and the integration of assessment to improve learning. The elements are not meant to be linear, with some elements being more important than others, but the emphasis will vary with each learning experience. The combination of elements has the strength to create an optimal learning environment for students.

EDTALK: JIGSAW

3. Participants will be using excerpts from the publication *EDTALK: What We Know About Mathematics Teaching and Learning.* Use the handouts **EDTALK Sections (4-52 through 4-58)** as five readings for a jigsaw (see **Appendix B-3**). Divide participants into home groups of five. Participants in a home group number off (one through five) and each individual joins an expert group with others of the same number from other home groups. Each expert group reads the designated section, discusses the ideas presented, and decides on the main points to share with the home group. Allow 20 minutes for expert group reading and discussion work.

   Have the experts return to their home groups and share their discussion. Ask home teams to use what they have learned about good mathematics education to develop recommendations about ways schools could be changed to promote better mathematics education. Allow 20 to 25 minutes for discussion and provide newsprint and markers for groups to record recommendations.

   Allow each group to report out their recommendations for improving mathematics education. Note similarities and differences in the lists.

4. If this has been a stand-alone activity from the *Toolkit*, relate the need for systemic change in the education process to bring about necessary reform in mathematics instruction and accessibility for all students.

5. If participants have experienced **Activity 1: Framing the Dialogue Around Systemic Change**, ask them to look back at their definitions of systemic change. What changes and/or additional

comments might they make to their definitions, given their deeper understanding of what needs to happen in mathematics education? Have them review their recommendations for improving mathematics education (from Step 3) and examine whether their action steps reflect a systems-thinking approach.

6. Ask participants to reflect on, talk about, and/or write: What have I learned in this activity? How can I use what I've learned?

EDTALK SECTIONS

What constitutes active instruction in mathematics?

American education has traditionally viewed the student as a kind of jug into which one pours information. But finally, some schools are rethinking this premise and more actively engaging students in the learning process.

Active instruction is based on research that recognizes learning as a dynamic process in which a child brings to bear the knowledge he or she already has. Rather than trying to transfer information to the child in a ready-made package, active instruction builds on each child's level of understanding and conceptual development. The teacher becomes less of a transmitter and more of a facilitator and organizer. The classroom becomes a lively place where students freely exchange ideas and learn concepts by talking, exploring, and discovering.

Active instruction encompasses a range of instructional approaches – small groups and cooperative learning, class discussion, teacher interviewing, and the use of hands-on experiences and concrete objects.

Active instruction encompasses a range of instructional approaches – small groups and cooperative learning, class discussion, teacher interviewing, and the use of hands-on experiences and concrete objects. It is well-suited to teaching higher order skills.

Communication, including listening, speaking, reading, and writing, is a major part of active instruction. Teachers ask students to justify their answers, think aloud, weigh different options for solving problems, and sometimes put their thoughts into writing. In this way, students organize their thinking and confront incomplete understanding; teachers can tell whether students have grasped important mathematical concepts. The goal is to create an atmosphere in which independent thinking flourishes.

Studies have shown that instruction that features active and hands-on experiences has a positive effect on mathematics achievement and improves student attitudes toward math.

Source: *EDTALK: What We Know About Mathematics Teaching and Learning* by Nancy Kober. Washington, DC: Council for Educational Development and Research. 1991, 19-25.

EDTALK SECTIONS (continued)

What produces gender inequity in math? How can these inequities be overcome?

Although research is divided about whether there are any meaningful gender differences in mental abilities, there is no evidence that females as a group have less aptitude for mathematics than males. At the elementary level there are few, if any, consistent gender differences. But by high school, even when the number of math courses taken is factored out, males score higher than females in math knowledge, skills, applications, and understanding.

Girls pay a high price for these achievement differences, which may prematurely foreclose their options for careers and higher education in math, science, and technical fields.

There is no evidence that females as a group have less aptitude for math than males.

A complex assortment of social forces produce or influence these gender inequities. Within the school, the attitudes of teachers and other staff and the interactions that occur in the classroom are key determinants. School counselors, for example, may subtly discourage girls from pursuing mathematics careers. Women teachers, who themselves may not be comfortable with mathematics, can foster inequities by sending out negative signals about math or treating males and females differently in the classroom.

One study found that fourth grade teachers were less likely to praise girls than boys for correct math responses and less willing to prompt girls who gave wrong answers. When teachers give feedback to girls on math work, they are more likely to focus on their intellectual abilities or work habits, whereas with boys, teachers are more apt to criticize such non-intellectual aspects as neatness and effort. Teachers in one study were eight times more likely to attribute boys' failure to a lack of motivation than they were girls' failure. Girls, moreover, tend to take this type of criticism to heart, as a true indicator of their talent.

EDTALK SECTIONS (continued)

Girls are particularly susceptible to a syndrome that has come to be called "learned helplessness." Learned helplessness sets in after a student has experienced what she perceives to be a "failure" in her early encounters with new material. Certain cues, such as the beginning of math class, resurrect the feelings of low self-esteem and ineptitude that accompanied those seminal experiences, and the student becomes unwilling or unable to adapt to new situations, even ones entirely within her control. The student comes to feel that there is little sense putting forth effort because she will not be able to do the problem anyway. The feelings of helplessness can transfer across tasks and become indelibly associated with math itself.

The methods of instruction may influence girls' achievement as well. For instance, there is some limited evidence that boys learn more on computers than girls, which raises important, unanswered equity questions.

Educators can take several actions to reduce or eliminate gender inequities in mathematics. At the building level, the school administrator can put together professional development workshops to help the whole staff learn to create a fairer environment. At the classroom level, teachers can monitor their own behavior and attitudes more closely, taking care to eliminate sex bias. At the student level, teachers can initiate activities that confront sex bias head on. Discussing math anxiety or learned helplessness with girls who are having problems, assigning students to keep journals, conducting formal assessments of attitude, discussing the usefulness of math and the career opportunities for boys and girls, bringing in successful women mathematicians to serve as role models – these are just a few of the options.

New studies suggest the efforts to reduce inequities that have occurred over the last several years may be paying off. A very recent study shows that as late as tenth grade, girls and boys are scoring equally well on basic math tests. The new data suggest the gap between male and female students may be disappearing, most likely as a result of more girls taking advanced courses.

EDTALK SECTIONS (continued)

What special problems do minority students face in math? What approaches can help overcome them?

Children of all races enter school with the capability to do math, but as they progress through the educational system, certain minority groups become underrepresented in mathematics classes and fail to fulfill their potential.

Research has focused mainly on African-American and Hispanic students. As early as first and second grades, differences in achievement among African-American, Hispanic, and white students emerge. By the end of second grade, a greater proportion of African-American and Hispanic students have slipped below grade level, compared to white and Asian students. By the end of elementary school, many Hispanics and African-American students have fallen so far behind that catching up may seem almost out of reach.

At the secondary level, large differences in performance and course enrollments exist between minority and majority students. Minority students who attend schools with high minority enrollments achieve even less than their minority peers in other schools. African-American students take about one year less of high school mathematics than the national average and are much more heavily enrolled in lower-level math courses, such as general math.

It is difficult to consider racial and ethnic disparities in mathematics achievement separate from socio-economic status. A disproportionate number of minority students come from low-income families or families where parents are not well-educated. Both income and parental education are strong influences on student achievement and coursetaking patterns, and these factors most certainly affect the minority students' achievement.

As with gender inequity, societal stereotypes, teacher attitudes and expectations, school climate, student attitudes, peer interactions, and classroom processes all come to bear on minority students' math performance.

As with gender inequity, societal stereotypes, teacher attitudes and expectations, school climate, student attitudes, peer interactions, and classroom processes all come to bear on minority students' math performance. For example, if a

EDTALK SECTIONS (continued)

teacher has preconceived expectations about minority student performance, that teacher may call on minority students less in class. Often there are few minority role models among the teaching staff, especially in math. Research corroborates that African-American students perceive differences in how they are treated in class. Research also indicates that minority students who do enroll in advanced classes tend to feel a sense of isolation and a greater need to prove themselves.

Many school districts have undertaken special efforts to increase the achievement and representation of African-American and Hispanic students, and these have led to noticeable improvements. As with gender inequity, school staffs need to become more aware of the influence of attitudes. Teachers need to monitor classroom processes such as the frequency and nature of their interactions with students of different races. Students must become more aware of their own attitudes and more sensitive to cultural differences of students from other racial and ethnic backgrounds. Techniques such as class discussions, student interviews, journal writing, and formal attitude assessments can help identify inequities.

EDTALK SECTIONS (continued)

What are the special needs of disabled students in mathematics?

Physicist Stephen Hawking demonstrates that persons with disabilities can be among the most gifted of mathematicians. Structuring an appropriate math education for the physically handicapped child may simply be a matter of providing the right instructional aids. Research shows that educational technology, including computers and calculators, can be adapted for use by disabled students and can result in higher math achievement and improved self image.

Research shows that educational technology, including computers and calculators, can be adapted for use by disabled students and can result in higher math achievement and improved self-image.

Math information processing is especially difficult for learning disabled (LD) students. The vocabulary, text format, structure, and use of symbols in mathematics texts can seem like insurmountable obstacles to LD children, who tend to have difficulty with decoding, visual-spatial relations, directionality, and sequencing. Direct instruction in the language of math can help students recognize and get over these hurdles.

Teachers should also be sensitive to the fact that the settings of word problems are often far removed from the disabled child's everyday life. Personalized problems and student-written problems can help overcome these barriers.

Cooperative learning approaches have also been shown to be successful in mainstreaming disabled children in the math classroom. And as with any component of a disabled child's educational program, an individualized approach tailored to the child's needs is advisable.

EDTALK SECTIONS (continued)

What are the special needs of mathematically gifted students and how can schools help meet them?

If the repetitiveness and slow pace of the typical mathematics curriculum is a problem for the average student, it is even more of a problem for mathematically gifted students. While gifted students enroll in advanced math courses more frequently than other students, even then they are often not challenged to achieve to the best of their potential.

Moreover, gifted female, minority, low-income, or disabled students are not always identified early enough or encouraged to pursue advanced courses. There is research evidence, for example, that stereotyped behavior of parents may impair the achievement of mathematically gifted girls.

It is usually not enough to provide a few enrichment experiences for gifted students; gifted students need opportunities, flexibility, and encouragement to move faster through their courses and tackle more challenging content. Successful math programs for gifted students focus on problem-oriented independent study, have dynamic teachers, use high-quality materials on a wide range of topics, and involve active recruiting and multiple measures to identify promising students. Gifted students also benefit greatly from interactions with intellectual peers through such activities as special competitions, contact with nearby universities, and summer programs.

Successful math programs for gifted students focus on problem-oriented independent study, have dynamic teachers, use high-quality materials on a wide range of topics, and involve active recruiting and multiple measures to identify promising students.

SECTION III:
EFFECTIVE DISSEMINATION STRATEGIES

Activity 5: What Is Effective Dissemination? 5-1

Activity 6: Effective Dissemination Strategies 6-1

Activity 7: Making Good Choices among Successful Practices 7-1

Section III: Effective Dissemination Strategies

People typically think of dissemination as spreading innovations (programs, materials, etc.) through presentations and distribution of print material. Yet, to be successful, disseminators need a broader perspective. They need to be able to meet audiences where they are and provide the type and depth of information needed to answer their audience's questions. Since these questions range from "What is it?" to "How do I do it?" to "Why isn't it working?" the disseminator needs a wide range of strategies to draw upon.

The purpose of Section III is to help participants broaden their definition of dissemination and their repertoire of strategies for responding to a wide range of needs. Activity 5 presents different types of dissemination and should be helpful for those who disseminate or refer people to a variety of programs, practices, materials, etc. Although Activity 6 introduces a variety of dissemination strategies, it focuses most attention on the first type of dissemination (spread). It should be especially useful for people who have their own program or practice to disseminate. Activity 7 focuses on the second type of dissemination, helping people make informed choices from a number of different offerings. Its audience includes school or district people who are responsible for making these choices, or others who help them. Sections IV and V of the *Toolkit* pay more attention to the other types of dissemination – exchange and implementation assistance – presenting different models for teacher learning and how to support change over time. The activities in Section III are:

- **Activity 5: What Is Effective Dissemination?** This activity presents a broad definition of dissemination, helping participants to analyze their own dissemination goals and strategies for breadth of reach and depth of impact.

- **Activity 6: Effective Dissemination Strategies.** This activity introduces and illustrates a variety of dissemination strategies, from awareness sessions to print brochures to training, materials, and implementation support. It focuses in-depth on awareness strategies. Participants set their own dissemination goals and select appropriate strategies for reaching them.

- **Activity 7: Making Good Choices among Successful Practices.** This activity provides a process for helping school and district staff identify and select from available programs and practices to improve science and mathematics education. Participants are guided to develop selection criteria and to practice applying those criteria to a set of successful programs.

Section III has been used in many situations, including:

- A regional educational laboratory and a National Diffusion Network State Facilitator, working collaboratively, used Section III to prepare regional service center science and mathematics staff to plan their training and support for schools, districts, and individual teachers. Participants analyzed their usual methods of assisting schools or districts in finding programs that match their needs, worked together to design a more efficient plan, and identified materials and resources via print and computer. They then used a matrix to evaluate potential programs against a site's needs and constraints and identified factors that promote successful dissemination of programs and practices.

- A regional educational laboratory identified ten promising science and mathematics programs and brought their developers together to work on strategies for sharing their successes. Using activities from Section III, the developers were able to identify their own dissemination strategies, broaden their goals for dissemination, and select some additional strategies that would help them reach their new goals.

5

WHAT IS EFFECTIVE DISSEMINATION?

Audience:

- Individuals responsible for disseminating exemplary science and mathematics practices, programs, or ideas, either their own or those of others.

Desired Outcomes for Participants:

- To define the term "dissemination" in the broadest sense.
- To identify potential outcomes of dissemination.
- To apply the concept of constructivist learning to the design of dissemination strategies.
- To explore a new dissemination paradigm that complements emerging definitions of systemic change.

Materials:

- **Transparencies:**
    - *What Do You Do to Disseminate New Programs, Practices, and Ideas?* (5-8)
    - *Alternative Definitions of Dissemination* (5-9)
    - *Types of Dissemination Activities* (5-10)
    - *Dissemination Continuum* (5-11)
    - *Outcomes of Dissemination* (5-12)
    - *According to Constructivism . . .* (5-13)
- **Handouts:**
    - *What Is Dissemination?* (5-14 and 5-15)
    - *Discussion Questions for "Revolution in One Classroom"* (5-16)
    - *Educational Dissemination Paradigm Elements* (5-17)
- **Reading:**
    - "Revolution in One Classroom (or, then again, was it?)" by David K. Cohen. *American Educator,* Fall 1991, 15 (2): 16-23, 44-48.
- Sample dissemination materials: brochures, videos, posters, training manuals, etc., being sure to include more than just print materials
- Overhead projector, screen, blank transparency, overhead pens
- Newsprint, easels, markers, tape, and colored adhesive dots

Time Required: Four hours

Facilitator's Notes: The primary purpose of this activity is to help participants understand that dissemination is a complex process whose success relies on being clear about outcomes (for example, do we want our audience simply to know about the process or to be able to do it?) and paying attention to the questions and needs of the audience over time. Participants begin by articulating their own conceptions of dissemination and then build an increasingly rich picture over the course of the activity.

A second purpose of this activity is to stimulate participants' thinking about the assumptions behind dissemination – how people come to "know" things and what helps them "borrow" from others. Dissemination has been criticized recently as part of an "old" paradigm that doesn't take into account how people learn and change. This old paradigm, often called positivism or instrumentalism, assumes that people can simply take up and use practices developed by others with a high degree of fidelity and get outcomes similar to those gained by the developers. This process is likened to the idea that students learn what a teacher teaches simply by taking in new information and being able to parrot it back.

The newer paradigm, that of constructivism, assumes that people – students and teachers alike – construct their own understanding from their current conceptions, to which they add new ideas or formulations in a way that makes sense to them. Constructivism relates to dissemination in viewing quality as relative and observing that people do not simply take on new programs or practices but have to reinvent them through a process that involves social interaction.

Critics of teaching the old way have been well received, as evidenced by the way every area of the school curriculum is changing to a more contructivist approach. Critics of dissemination, as well as experienced disseminators, are also coming to believe that a new paradigm is necessary – that effective dissemination incorporates the recipients' needs to construct their own understanding of a new practice or approach.

This is a useful discussion for individuals in dissemination roles. By examining new theoretical perspectives, we better understand how clients think about and then take up new, exemplary programs and ideas. With that understanding, we can make our dissemination strategies more sensitive and relevant and, in doing so, more effective.

The activity begins by asking participants to think about what dissemination means to them and how they do it. They are then introduced to a broad definition and challenged to begin expanding their views.

Process:

1. Put two pieces of newsprint and markers on each table. Display the **What Do You Do to Disseminate New Programs, Practices, and Ideas? (5-8)** transparency and ask participants to work in groups of three or four to draw on one piece of newsprint what they do to disseminate their own or others' programs, practices, and ideas. Ask them to talk about their drawings at their tables and together keep a list of the words they use to describe dissemination. Ask each table to use those words to develop their own definition of dissemination. Have them write the definition on newsprint and post it.

2. Show the **Alternative Definitions of Dissemination (5-9)** transparency. Ask participants what they observe about their own definitions as well as these. Some observations may be:

   - They're different (probe: in what ways).
   - They assume different things are being disseminated (programs, ideas, research, etc.).
   - They call for different outcomes (awareness, change in teaching, etc.).

   Note that for many years people have been examining the process of dissemination in order to make it more successful. In 1979, the federally sponsored Dissemination Analysis Group suggested broadening the definition of dissemination to include four types of activities, each with somewhat different goals. Show the **Types of Dissemination Activities (5-10)** transparency and pass out the supporting handout **What Is Dissemination? (5-14 and 5-15)**. Review the four types and ask:

   - What questions from audiences do each of these types of dissemination respond to? (For example, spread responds to "What does it look like?" and "What would I have to do differently?" while implementation assistance responds to "How can I expand my use to include my gifted students?" and "How can I shorten the amount of time it's taking me to prepare each night?")
   - What are some examples of each type of dissemination?

3. Show the **Dissemination Continuum (5-11)** transparency. Ask participants to draw a continuum on newsprint (one per table) and place (write) the dissemination activities they do somewhere on the continuum. Allow five to ten minutes. Ask for some examples of what they put where.

   Have participants reflect on their continuum by asking the following questions.

   - How does your continuum represent the four types of dissemination?
   - How are your dissemination efforts distributed across the four types? Are the four types mutually exclusive? Explain.
   - Do some of the questions you hear from audiences require different types of dissemination activities than what you're currently using?
   - What else do you observe?

4. Note that different dissemination activities often have different goals. Use the **Outcomes of Dissemination (5-12)** transparency to describe these goals. Ask participants to code the activities on their group's continuum according to the outcomes: K (knowledge), I (individual practice), S (the system). Ask for their observations (e.g., were all outcomes represented?). Have participants work in their groups to do/discuss the following:

   - Identify the intended outcomes for dissemination of their efforts.
   - Determine if there is a match between the dissemination activities listed on their newsprint and desired outcomes.
   - What they would need to do differently (in terms of dissemination efforts) to realize outcomes that promote changes in practice, and finally, systems.

5. Share with participants some sample dissemination materials. Ask participants how these materials could be used in dissemination. What outcomes would they achieve?

6. This next part of the activity moves to rethinking the roles and functions of dissemination as cognitive research sheds light on how people learn and what causes them to change. Ask participants to

imagine that they came upon a new science or mathematics program. Have them imagine two scenarios. In one they "adopt" the program exactly as it is, relying exclusively on the materials and a teacher's guide to inform their instruction and content coverage. In the other scenario, they "adapt" the program to their own framework or curriculum scope and sequence. They use some pieces intact and rearrange or embellish other parts with supplemental materials and their own touch. Have participants turn to a partner and share their own experiences with this phenomenon.

Remind participants that new roles for science and mathematics teachers – moving from *givers of knowledge* to *facilitators of learning* – are based on the idea that individuals construct their own understandings. Say that examining, trying out, and then adapting programs, ideas, and practices helps individuals to "own" them as they build deep understanding by working through the "what" and "how" of the new material.

Display and read the **According to Constructivism . . . (5-13)** transparency. Ask participants to discuss in their groups how some of the activities they listed on their newsprint are "constructivist" or how they might be changed to be more so. Have each group choose one activity to discuss.

After ten minutes, ask for one example per group – list them on newsprint or a blank transparency under the heading "Examples of Constructivist Dissemination Activities." Discuss what makes them so.

Note: If you choose not to do the optional activity, skip to Step 9.

7. *(Optional)* This activity goes into depth about what it means to help teachers "construct" or "reconstruct" their knowledge and change their behavior accordingly. It involves a case study of a teacher who has "adopted a new practice" by his or her own self report.

Either distribute the article "Revolution in One Classroom" ahead of time and ask participants to read it, or construct a jigsaw (see **Appendix B-3**) for groups of four to five to read parts and "teach" them to each other. Prepare participants by saying that this is a very provocative article, critical of the teacher; they may find it difficult to read without wanting to defend the teacher. However, it was chosen because it will stimulate discussion about our role as disseminators.

Distribute the handout **Discussion Questions for "Revolution in One Classroom" (5-16)** and allow 20 to 30 minutes for discussion. Ask them to report out their responses to #3, #4, and #5 to the large group.

8. Explain to participants that some people and organizations who have responsibility for dissemination are currently rethinking their roles and functions in light of systemic change. The handout **Educational Dissemination Paradigm Elements (5-17)** is a first draft by the National Dissemination Association's Executive Director that contrasts characteristics of the old dissemination paradigm with ones of a new paradigm. Distribute the handout and encourage participants to join the dialogue. Ask them to work in their groups to change, delete, and add elements. Have them also compare which elements are most relevant to their current work. Note that the association that developed this chart focuses on the dissemination of programs, so one thing participants might do, if they are more involved in disseminating other things (e.g., ideas, research results, practices) is to change the focus. Allow 20 minutes.

   While the groups are working, make a large wall chart by transferring characteristics from the handout **Educational Dissemination Paradigm Elements (5-17)** onto several pieces of newsprint.

   Ask the groups to come to the wall chart to make additions to the existing list. Have each group report out one insight from working with the contrasting columns.

   Provide six colored adhesive dots to each participant and ask them to place the dots next to the six elements on the wall chart that they individually feel are most critical. Encourage the group to analyze the graph formed: What do they notice about priorities depicted? Ask them to dialogue about patterns and issues.

9. Ask participants to refer to their definitions of systemic change, developed in **Activity 1: Framing the Dialogue Around Systemic Change**. How does their expanded view of dissemination relate to this definition? What can they do to be more systemic in their dissemination activity?

10. Ask each participant to think about what was discussed in the session and complete this stem:

    The most important thing I need to do to improve my dissemination effectiveness is. . . .

Additional References:

Cohen, David K. Fall 1991. "Revolution in One Classroom (or, then again, was it?)." *American Educator* 15 (2): 16-23, 44-48.

Crandall, David. 1989. "Implementation Aspects of Dissemination: Reflections Toward an Inmodest Proposal." *Knowledge: Creation, Diffusion, Utilization* 11 (1): 79-106.

Ely, Donald P. and A. Michael Huberman. 1993. *User-Friendly Handbook for Project Dissemination: Science, Mathematics, Engineering and Technology Education*. Washington, DC: National Science Foundation.

Huberman, A. Michael. June 1987. "Steps Toward an Integrated Model of Research Utilization." *Knowledge: Creation, Diffusion, Utilization* 8 (4): 586-611.

Hutchinson, Janet and A. Michael Huberman. 1993. "Knowledge Dissemination and Use in Science and Mathematics Education: A Literature Review." Washington, DC: The National Science Foundation.

Klein, Susan Shurberg. March 1992. "A Framework for Redesigning an R&D-Based National Education Dissemination System in the United States." *Knowledge: Creation, Diffusion, Utilization* 13 (3): 256-286.

What do you do to disseminate

new programs, practices,

and ideas?

ALTERNATIVE DEFINITIONS OF DISSEMINATION

1. A process of communicating information to specific audiences in order to extend knowledge and, in some cases, modify policies and practices.

2. An organized effort to convey information about effective programs, including knowledge from actual practice, in order to achieve similar results.

TYPES OF DISSEMINATION ACTIVITIES

Spread	One-way broadcasting of information to increase awareness
Choice	Providing information on alternatives to inform decision making
Exchange	Sharing information, materials, or perspectives related to refining programs, practices, or ideas
Implementation	Training, assistance, and support for using a new program or practice

DISSEMINATION CONTINUUM

Spread – Choice – Exchange – Implementation

OUTCOMES OF DISSEMINATION

- Increased knowledge
- Changed individual practice
- Changed systems, cultures, organizational structures

According to constructivism, "the 'user' acts upon information by relating it to existing knowledge, imposing meaning and organization on experiences and, in many cases, monitoring understanding throughout the process. This casts the 'user' as an active problem solver and a constructor of his or her own knowledge, rather than a more passive receptacle of information and expertise."

— Hutchinson and Huberman, 1993

Source: Hutchinson, Janet and A. Michael Huberman. 1993. "Knowledge Dissemination and Use in Science and Mathematics Education: A Literature Review." Washington, DC: The National Science Foundation.

WHAT IS DISSEMINATION?

". . . [T]o scatter widely as in sowing seed . . . to spread abroad . . ." is Webster's definition. Most people would say that dissemination is the process of getting information and products to potential users. Unfortunately, that view is not sufficient. Without working on the **reception** side, you may have a message that virtually no one listens to, much less acts on.

For a long time, researchers in the social sciences aligned themselves with engineers. The idea was that a rational research and development process (Research → Development → Dissemination) would be sufficient to do the job. As it turned out, what is needed in the social and behavioral sciences is a more complex and less linear model for transferring knowledge from developers and researchers to users. Here is a definition that more accurately reflects the complexity of the process:

> **Dissemination is the process of communicating information to specific audiences for the purpose of extending knowledge and, in some cases, with a view to modifying policies and practices.**

Within the definition are concepts dealing with four different goals of dissemination: **spread** of information, **choice** of alternative products or procedures, **exchange** of information, and **implementation** of new processes or procedures (Klein 1992). Let us explore these four goals.

When **spread** is the focus of the dissemination effort, a variety of media formats are usually considered, e.g., audio, video, or text, using one or more vehicles: presentation at professional meetings, publications in journals, and telecommunications. Spread is usually aimed at a large number of people and reaches them at random. A targeted spread would define audiences more narrowly and confine communication to those journals read by the specific audience; to those conferences attended by the defined audience; and to telecommunications networks that are likely to include members of the target group.

Dissemination as **choice** involves the communication of information about alternative products, practices, programs, and policies. It is delivered by libraries, information centers, and clearinghouses. Its function is to help users to locate needed information that is not usually available at their fingertips. With easier access to databases online and toll-free telephone numbers, information can be obtained so that choice of relevant data can be made. However, for successful dissemination, the information must be put into the system and users must become aware of its availability. Placement of

Source: *User-Friendly Handbook for Project Dissemination: Science, Mathematics, Engineering, and Technology Education* by Donald P. Ely and A. Michael Huberman. Washington, DC: National Science Foundation. 1993, 5-7.

WHAT IS DISSEMINATION? (continued)

information into a database is no guarantee of eventual dissemination; it occurs only when someone knows enough to request it.

Exchange occurs when information, products, or observations are shared. Examples of exchange involve interactive communication through face-to-face visits, e-mail messages, and informal conversations at professional meetings. The "audience" is usually smaller – individuals or small groups who sometimes form networks for the purpose of sharing research findings, new information, and availability of materials.

Implementation is the actual use of information by other practitioners and is fostered by direct assistance to the user. It may include training in the use of a new product or procedure through a local team trained by the original developer; it may be a "help" screen on a computer or a toll-free telephone number that facilitates implementation. Implementation is actually one of the major purposes of dissemination. It is often assumed to occur simply because information has been sent. Crandall (1989) concludes:

> **Policies that involve clearly defined and validated practices, when linked with in-person assistance from experienced developers, implementors, and facilitators, appear to have a greater chance for improving school practice.**

Dissemination is context dependent. People in various settings often act on the basis of traditions and values of the organization. These are general procedures or guidelines that are useful but absolute rules do not exist.

DISCUSSION QUESTIONS FOR " REVOLUTION IN ONE CLASSROOM "

1. What does this article have to do with the idea of "constructivism," both on the part of Mrs. Oublier and of her students?

2. What had been the dissemination activities that brought Mrs. Oublier to where she was?

3. What dissemination activities might have changed the nature of Mrs. Oublier's classroom "revolution" to one more in line with the California framework and the NCTM standards?

4. What questions do you have about Mrs. Oublier's case?

5. What issues does this case raise?

EDUCATIONAL DISSEMINATION PARADIGM ELEMENTS
— WORK IN PROGRESS —

Old Dissemination Paradigm	New Dissemination Paradigm
Quantity	Quality
Adoption	Adaptation
Replication	Implementation
Short-term	Long-term
Product	Process
Classroom or school-based	System-based
Developer produced, adopter accepted	Developer-implementer cooperatively produced
Fidelity of adoptions	Fidelity only of developer's critical, key elements; wide variation for rest
Outcome of intervention is acceptance by recipient	Outcome of intervention is impact of collaborative implementation
Programs evaluated once – "validated" before dissemination	Programs evaluated continually, throughout implementation process
Packaged programs	Program components reconstructed by implementer, "tinker-toy"-like
One-way communication	Interactive dialogue
Singular training events	Follow-up/follow-through
Singular program implementation	Cooperative, bundled program implementation
Exemplary, singular teacher	Networks of cooperative teachers

Source: Reprinted with permission of the National Dissemination Association from "Educational Dissemination Paradigm Elements." ©1993.

Reprinted with permission from the Fall 1991
issue of the AMERICAN EDUCATOR, the quarterly
journal of the American Federation of Teachers.

REVOLUTION IN ONE CLASSROOM

(or, then again, was it?)

BY DAVID K. COHEN

AS MRS. Oublier sees it, her classroom is a new world. When she began six or seven years ago, she was a thoroughly traditional teacher. She reported that she followed the mathematics text. Her second graders spent most of their time on worksheets. Learning math meant memorizing facts and procedures. Then Mrs. O found a new way to teach math. The summer after her first year of teaching, she took a workshop in which she learned to focus lessons on students' understanding of mathematical ideas. She found ways to relate mathematical concepts to students' knowledge and experience. And she learned how to engage students in actively understanding mathematics.

Mrs. O's story is a timely one. I encountered her in the late 1980s, as reformers once again began trying to change mathematics teaching and learning from mechanical drill and memorization to reasoning and understanding. Since the early twentieth century, mathematicians and math educators had intermittently insisted that students should learn to reason mathematically, to apply mathematical ideas to everyday situations, and to understand the conceptual basis of mathematics. But in the 1980s, state and national education leaders, chagrined about reports of weak school performance and worried about America's economic situation, gave new force to demands for reform.

These are revolutionary aspirations, at least judged by current classroom practice. But the new ambitions are being taken quite seriously. The National Council of Teachers of Mathematics has formulated an ambitious new set of standards for teaching and curriculum, which have received favorable attention in many quarters, including the secretary of education and the president. Several states are trying to realize the new ideas. For instance , since 1985, California's department of education has been pressing a remarkable program of reform in mathematics teaching and learning. The state issued a new curriculum framework. It then required publishers to re-orient math textbooks to conform more closely to new ideas about instruction. It also began to re-write the state testing program so that it assesses students' understanding and reasoning. And it has been offering workshops and other assistance to teachers.

Mrs. O teaches in California and sees her work as part of the changes that the state is trying to promote. Her story is engaging, and so is she. She is considerate of her students, eager for them to learn, energetic, and attractive. These qualities would stand out anywhere, but they seem particularly vivid in her school—a drab collection of one-story concrete buildings that sprawl over several

ILLUSTRATED BY BRU ASSOCIATES

David K. Cohen is John A. Hannah Distinguished Professor of Education and Social Policy at Michigan State University in East Lansing. A somewhat different version of this essay was published in Educational Evaluation and Policy Analysis, *Fall 1990.*

acres. Though clean and well managed, her school has none of the familiar signs of classy education. It has no legacy of experimentation or progressive pedagogy, or even of heavy spending on education. Only a minority of children come from well-off families. Most have middling or modest incomes, and many are eligible for Chapter 1 assistance. A sizable minority are on welfare. The school district is situated in a dusty corner of southern California, where city migrants are turning a rural town into a suburb. New condominiums are sprouting up all over the community, but one still sees pick-up trucks with rifle racks in their rear windows. Like several of her colleagues, Mrs. O works in a covey of tacky, portable, prefab classrooms, trucked into the back of the schoolyard to absorb growing enrollments on the cheap.

Mrs. O's story seems even more unlikely when considered against the history of American educational reform. Great plans for educational change are familiar in that history, but so are reports of failed reform. John Dewey and others announced a revolution in pedagogy just as our century opened, but apparently it fizzled, for classrooms changed only a little (Cuban, 1984). That also seems to have been the fate of the earlier "new math" in the 1950s and 1960s and of related efforts to improve science teaching (Welch, 1979). Since then, many studies of instructional innovation have embroidered these old themes of great ambitions and modest results (Gross, et al., 1971; Berman and McLaughlin, 1977; Rowan and Guthrie, 1989; Cohen, 1988).

Some analysts attribute these results to teachers' resistance, saying that entrenched classroom habits defeat reform (Gross, et al., 1971). Others report that many innovations fail because they are so poorly adapted to the classroom that even teachers who avidly desire change can do little (Cuban, 1984; Cuban, 1986). Mrs O's revolution looks particularly appealing against this background. She eagerly embraced change, rather than resisting it, finding new ideas and materials that worked in her classroom. Mrs. O sees her class as a success for the new mathematics Framework. She reports that her math teaching has wound up where the Framework wants it to be.

SOMETHING OLD AND SOMETHING NEW

One prominent feature of Mrs. O's teaching is her use of innovative instructional materials and activities designed to help students make sense of mathematics. But she used these new activities and materials quite traditionally, as though mathematics contained only right and wrong answers. Similarly, while she had revised the class organization and activities to help students understand math, she managed the discourse in ways that discouraged exploration of students' understanding.

In fact, Mrs. O's lessons were quite mixed. They contained some important elements that reformers embraced, but others that they branded inadequate. Her classes present an extraordinary *mélange* of tradition and novel approaches to math instruction, which is one reason that they deserve attention. For such mixtures are quite common in instructional innovations, though little noticed. As teachers and students try to find their way from familiar practices to new ones, they cobble new

Students' number sentences were accepted if correct, and written down on the board. But they were turned down if incorrect, and not written on the board. Right answers were not explained, and wrong answers were treated as unreal.

ideas together with old practices. Teachers' ingenuity is remarkable, but the mixtures raise fundamental questions. Can we say that an innovation has made much progress when it is tangled up with many traditional practices? What might it take to help teachers continue to learn and change? These questions have a special urgency just now, as reformers urge teachers to radically revise their work in math and other subjects.

New Materials, Old Mathematics

From one angle, the curriculum and instructional materials in this class looked just like what the new California math Framework invited. For instance, Mrs. O regularly asked her second graders to work on "number sentences." In one class that I observed, students had just done the problem: 10+4=14. Mrs. O then asked them to generate additional "number sentences" about 14. They volunteered various ways to write addition problems about fourteen—that is, 10+1+1+1+1=14, 5+5+4=14, etc. Some students proposed several ways to write subtraction problems—that is, 14-4=10, 14-10=4, etc. Most of the students' proposals were correct. Such work could make mathematical relationships more accessible, by coming at them with ordinary language rather than working only with bare numbers on a page. It also could unpack mathematical relationships, by offering different ways to get the same result. It could illuminate the reversible relations between addition and subtraction. And it could get students to do "mental math," i.e., to solve problems in their heads and thereby learn to see math as something to puzzle about and figure out, rather than just a bunch of facts and procedures to be memorized.

These are all things that the new Framework celebrated. It exhorted teachers to help students cultivate "... an attitude of curiosity and the willingness to probe and explore ..." (California State Department of Education [CSDE], 1985, p.1). It also called for classroom work that helps students "... to understand why computational algorithms are constructed in particular forms ..." (CSDE, 1985, p.4).

But Mrs. O conducted the entire exercise in a thoroughly traditional fashion. The class recited in response to the teacher's queries. Students' sentences were accepted if correct, and written down on the board. But they were turned down if incorrect, and not written on the board. Right answers were not explained, and wrong answers were treated as unreal. The Framework made no such distinction, arguing instead that understanding how to arrive at answers is an essential part of helping students figure out how mathematics works—no less important than whether the answers are right or wrong. The Framework criticized the usual algorithmic approach to mathematics, and the usual search for the right answer. It called for class discussion of problems as an important part of figuring out mathematical relationships (CSDE, 1985, pp. 13-14). But no one in Mrs. O's class was asked to explain his or her proposed number sentences, whether correct or not. No student was invited to demonstrate how he or she knew whether a sentence was correct or not. The teacher used a new mathematics curriculum, but used it in a way that conveyed a sense of mathematics as a fixed body of knowledge of right answers rather than as a field of inquiry.

The mixture of new mathematical ideas and materials with old mathematical knowledge and pedagogy showed up elsewhere in Mrs. O's work. She used concrete materials and other physical activities extensively to represent mathematical concepts in forms that are vivid and accessible to young children. She opened every day with a calendar activity in which she and the students gathered on a rug at one side of the room to count up the days of the school year. She used this activity for various purposes. During my first visit, she was familiarizing students with place value, regrouping, and odd and even numbers. As it happened, my visit began on the thirty-ninth day of the school year, and so the class counted to thirty-nine. They used single claps for most numbers but double claps for ten, twenty, etc. Thus, one physical activity represented the "tens" and distinguished them from another physical activity that was used to represent the "ones." The idea was that fundamental distinctions among types of numbers can be represented in ways that make immediate sense to young children and that will easily familiarize them with important mathematical ideas.

Mrs. O's class abounds with such activities and materials, and they are very different from the bare numbers on worksheets that would be found in a traditional math class. Her approach seems nicely attuned to the new Framework. For instance, that document argues that "many activities should involve concrete experiences so that students develop a sense of what numbers mean and how they are related before they are asked to add, subtract, multiply, or divide them (CSDE, 1985, p. 8). And it adds that "concrete materials provide a way for students to connect their own understandings about real objects and their own experiences to mathematical concepts. They gain direct experience with the underlying principles of each concept" (CSDE, 1985, p.15).

But it is one thing to embrace a doctrine of instruction and quite another to weave it deeply into one's practice. For even rather monotonous teaching comprises many different threads, and any new instructional element is somehow related to many others already there. The new thread can simply be dropped onto the fabric, and everything else left as is. Or new threads may be somehow woven into the fabric. Mrs. O introduced new threads but only slightly re-adjusted the old ones. Hence the novel materials and activities were infused with traditional messages about what mathematics was and what it meant to understand it.

These mixed qualities were vividly apparent in a lesson that focused on addition and subtraction with regrouping. The lesson occurred early in an eight-or ten-week cycle concerning these topics. Like many of Mrs. O's lessons, it combined a game-like activity with the use of concrete materials. She hoped to capture children's interest in math while helping them to understand it. Mrs. O introduced this lesson by announcing: "Boys and girls, today we are going to play a counting game. Inside this paper [holding up a wadded-up sheet of paper] is the secret message...." Mrs. O unwadded the paper and held it up: "6" was inscribed. The number was important because it would establish the number base for the lesson: Six. In previous lessons, they had done the same thing with four and five. So part of the story here was exploring how things work in different number bases, and one reason for that, presumably, was to get some perspective on the base-ten system that we conventionally use. Mrs. O told the children that, as in the previous games, they would use a nonsense word in place of the secret number. This time they selected "cat's eye" to stand in for six.

With this groundwork laid, Mrs. O had "place-value boards" given to each student. She held up her board: It was roughly eight by eleven; one half was blue, the other white. She said: "We call this a place-value board. What do you notice about it?"

Cristie Smith, who turned out to be a steady infielder on Mrs. O's team, said: "There's a smiling face at the top." Mrs. O agreed, noting that the smiling face needed to be at the top at all times [that would keep the blue half of the board to everyone's left]. Several kids held theirs up for inspection from various angles, and she admonished them to leave the boards flat on their tables at all times.

"What else do we notice?" she inquired. Sam said that one half is blue and the other white. Mrs. O agreed and went on to say that ". . . the blue side will be the cat's eye side. During this game we will add one to the white side, and when we get a cat's eye, we will move it over to the blue side." With that, each student was given a small plastic tub, which contained a handful of dried beans and half a dozen small paper cups, perhaps a third the size of those dispensed in dentists' offices. This was the sum total of pre-lesson framing—no other discussion or description preceded the work.

There was a small flurry of activity as students took their tubs and checked out the contents. Beans present nearly endless mischievous possibilities, and several of the kids seemed on the verge of exploring their properties as guided missiles. Mrs. O nipped off these investigations, saying: "Put your tubs at the top of your desks, and put both hands in the air." The students complied, as though in a small stagecoach robbery. "Please keep them up while I talk." She opened a spiral-bound book, not the school district's adopted text but *Math Their Way*. This was the innovative curriculum guide that had helped to spark her revolution. She looked at it from time to time as the lesson progressed but seemed to have quite a good grip on the activity.

Mrs. O got things off to a brisk start: "Boys and girls [who still were in the holdup], when I clap my hands, add a bean to the white side."

She clapped once vigorously, adding that they could put their hands down. "Now we are going to read what we have: What do we have?" (She led a choral chant of the answer.) "Zero cat's eye and one." She asked students to repeat that, and everyone did. She clapped again, and students obediently added a second bean to the white portion of the card. "What do we have now?" she inquired. Again she led a choral chant: "Zero cat's eye and two." So another part of the story in this lesson was place value: "Zero cat's eye denoted what would be the "tens" place in the base-ten numbering, and "two" is the "one's" place. Counting individual beans and beans grouped in "cat's eye" would give the kids a first-hand, physical sense of how place value worked in this and other number bases.

In these opening chants, as in all subsequent ones, Mrs. O performed as much as a drill sergeant as a choir director. Rather than establishing a beat and then maintaining it, she led each chant and the class followed at a split-second interval. Any kid who didn't grasp the idea needed only to wait for her cue or for his table-mates. Students were never invited or allowed to count on their own. Thus, while the *leitmotif* in their second chant was "zero cat's eye and two," there was an audible minor theme of "zero cat's eye and one." That several students repeated the first chant suggested that they did not get either the routine or its point.

Mrs. O moved right on nonetheless, saying that it ". . . is very important that you read the numbers with your hands." This was a matter to which she returned many times during the lesson, reminding children to put their little paws first on the beans in the white square and then on the little cups on the blue square as they incanted the mathematical chants. She seemed to feel it essential that they manipulate the concrete materials. Whenever she spotted a child who was not palpitating beans and cups, she walked over and moved their arms and hands for them.

Mrs. O led the bean adding and chants up to five. Then, with five beans down on everyone's card, she asked: "Now think ahead; when I clap my hands this time, what will you have on the white side?"

Reliable Cristie Smith scooped it up and threw smoothly to first: "Cat's eye."

Mrs. O led off again: "When you get a cat's eye, put all the beans in a paper cup and move them over." She clapped her hands for the cat's eye and then led the following chant: "Put the beans in the cup and move them over."

"Now let's read what we have." The chant rolled on: "One cat's eye and zero." A puzzling undercurrent of "one cat's eye and one" went unattended. She then led the class through a series of claps and chants, leading up to two cat's eyes. And then, with a methodical monotony, up to five cat's eyes and five. By the time they got to five cat's eyes and five, her claps had grown more perfunctory, and many kids had gotten the fidgets. But Mrs. O saw this chanting and bean-pawing as the high road to mathematical understanding and tenaciously drove her team on.

"Now, how many do we have?" "Five cat's eyes and five beans," came the chant. "Now we will take away one bean" (from the "ones" side of the board). "How many do we have?" Again the answering chant, again led by her, a fraction of a second earlier: "Five cat's eyes and four."

This was a crucial point, for the class was moving from a representation of addition with regrouping to a representation of subtraction with regrouping. It would have been an obvious moment for some such comment or discussion, at least if one saw the articulation of ideas as part of understanding mathematics. But Mrs. O did not comment or explain. She took an activity-based approach, as though all the important ideas were implicit, and better that way.

Thus the class counted down to five cat's eyes and zero. Mrs. O then asked, "What do we do now?" Jane responded: "Take a dish from the cat's eye side and move it to the white side." No explanation was requested or offered to embroider this response. Mrs. O simply approved the answer, clapped her hands, and everyone followed Jane's lead. With this, Mrs. O led the class back

Her inspiration for all this was **Math Their Way**, *on which Mrs. O relied heavily.*

through each step, with claps, chants, and reminders to "read" the beans with their hands, down to zero cat's eye and zero beans. Everyone was flagging long before it was done, but not a chant was skipped or a movement missed.

Why did Mrs. O teach in this fashion? In an interview following the lesson, I asked what she thought the children learned from the exercise. She said that manipulating the materials helped them to understand what goes on in addition and subtraction with regrouping. She seemed convinced that these physical experiences caused learning, that mathematical knowledge arose from the activities.

Her inspiration for all this was *Math Their Way*, on which Mrs. O relied heavily. This increasingly popular book, a system of primary grade math teaching, announces that it will help "... to develop understanding and insight of the patterns of mathematics through the use of concrete materials" (Baratta-Lorton, 1976: xiv). Concrete materials and physical activities are crucial because they are believed to provide real experience with mathematics. The book sharply distinguishes between mathematical symbols and concepts and criticizes teaching with symbols. Symbols—that is, numbers— "... are not *the concept* [emphasis in original], they are only a representation of the concept, and as such are abstractions describing something which is not visible to the child. Real materials, on the other hand, can be manipulated to illustrate the concept concretely, and can be experienced visually by the child. ... The emphasis throughout this book is making concepts, rather than numerical symbols, meaningful" (Baratta-Lorton, 1976: xiv).

Math Their Way fairly oozes with the belief that physical representations are much more real than symbolic ones. This idea is a recent mathematical mutation of the idea, at least as old as Rousseau, Pestalozzi, and James Fenimore Cooper, that experience is a better teacher than books. For experience is vivid, vital, and immediate, while books are all abstract ideas and dead formulations. *Math Their Way* also claims that concrete materials are developmentally desirable for young children. Numbers are referred to many times as an "adult" way of approaching math. That idea leads to another, still more important: If math is taught properly, it will be easy. Activities with concrete materials, the book insists, are the natural way for kids to learn math: "... if this foundation is firmly laid, dealing with abstract numbers will be effortless" (Baratta-Lorton, 1976: 176).

Stated so baldly, that seems a phenomenal claim. Simply beginning with the proper activities and materials ensures that math will be understood well and easily. But the idea is quite common. Pestalozzi might have cheered it. Many other pedagogical Romantics, Rousseau and Dewey among them, embraced a version of this view. Piaget is commonly thought to have endorsed a similar idea. So when *Math Their Way* argues that the key to teaching math for understanding is to get children to use the right sorts of activities and materials, it is in one of the main lines of modern educational thought and practice.

The book's claim also helps to explain why it gives so little attention to the explanation of mathematical ideas. For the author seems convinced that it is superfluous.

Appropriate materials and activities alone will do the trick. Students will "understand" math without any need to question or explain mathematical ideas. This made *Math Their Way* an appealing package, for it enabled Mrs. O to whole-heartedly embrace teaching math for understanding, without considering or reconsidering mathematics. She was keen that children should understand math and worked hard at helping them. But she placed nearly the entire weight of this effort on concrete materials and activities. Her use of the materials, insisting that all the children actually feel them and perform the same prescribed physical operations with them, suggests that she endowed them with enormous, even magical, instructional powers. The lack of any other ways of making sense of mathematics in her lessons was no oversight. With *Math Their Way*, she simply saw no need for anything else.

Her use of the materials, insisting that all the children actually feel them and perform the same prescribed physical operations with them, suggests that she endowed them with enormous, even magical, instructional powers.

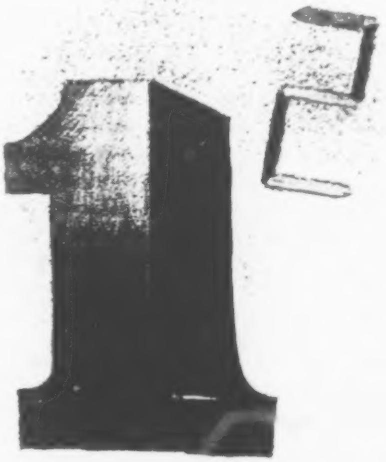
In what sense was Mrs. O teaching for understanding? The question opens up a great puzzle. Her classes exuded traditional conceptions of mathematical knowledge and were organized as though explanation and discussion were irrelevant to mathematics. But she had changed her math teaching quite dramatically. She now used a new curriculum specifically designed to promote students' understanding of mathematics, as opposed to simple memorization. And her students worked with materials that represented mathematical relationships in the concrete ways that the Framework and many other authorities endorse.

New Topics and Old Knowledge

The puzzle was apparent in other features of Mrs. O's teaching. For instance, she taught several topics that would not have been covered in many traditional math classes, among them estimation. She told me that estimation is important because it helps students to make sense of numbers by making educated guesses and figuring out why some guesses are better than others. She reported that she dealt with estimation recurrently in her second-grade classwork, for it could not be learned by doing it once or twice, and is useful in many different problem-solving situations. Her reasoning on this matter seemed to accord with the Framework's call for "guessing and checking the result" as an important element in mathematical problem solving (CSDE, 1985, p. 14).

But the teaching that I observed did not entirely realize these ambitions. In one lesson, Mrs. O asked the class to estimate how many large paper clips would be required to span one edge of her desk. Two students were enlisted to stand near the desk and hold up the clips. They were near enough to visually gauge its width in relation to the clips, but all the other students remained at their tables, scattered around the room. None had any clips, and few could see the edge of the teacher's desk that was in question, for it was a side edge, away from most of the class. Seated at the back with many of the kids, I could see that they were the large sort of clip, but even then they were barely visible.

So only two members of the class had real contact with the two key data sources in the problem—visible, palpable clips and a clear view of the desk edge. Hence only two members of the class had any solid basis for deciding if their estimates were mathematically reasonable. Even Mrs. O was seated too far away to see the edge well.



The problem was sensible and could have been an opportunity to make and discuss estimates of a real puzzle. But it was set up in a way that frustrated mathematical sense making.

Mrs. O did not seem aware of this. She asked the students to estimate how many clips it would take to cover the edge and to write down their answers. Then she took estimates from most of the class, wrote them on the board, and asked class members if the estimates were "reasonable." Not surprisingly, many of the answers lacked mathematical discrimination. Estimates that were close to three times the actual answer, or one-third of it, were accepted by the class and the teacher as "reasonable." Indeed, no answers were rejected as unreasonable, even though quite a few were far from the mark. Nor were some estimates distinguished as more or less reasonable than others. Mrs. O did ask the class what "reasonable" meant, and one boy offered an appropriate answer, suggesting that the class had some previous contact with this idea.

I could see nothing that led inexorably to this treatment. Mrs. O had many clips. If eight or ten had been passed around, the kids would have had at least a bit of direct access to one element in the estimation problem. She also could have pointed to the desk edge that the class could see, rather than the far edge that was obscured from their view. Alternatively, she could have invited them to estimate the length of their own desk edges, which were all the same standard-issue models. Either or both would have given them much more direct contact with the elements of the problem and more of a basis to consider how reasonable their estimates were.

Why did Mrs. O not set the problem up in one of these ways? In an interview after the class, she displayed no sense that anything had been wrong, in response to my queries. She seemed to understand the broad purpose of teaching and learning estimation, but she taught as though she lacked the mathematical and pedagogical infrastructure—the knowledge of mathematics, and of teaching and learning mathematics—that would have helped her to set the problem up so that the crucial mathematical data were available to students. And despite her earlier comments, Mrs. O presented estimation as a topic in its own right rather than as a part of solving problems that came up in the course of studying mathematics. It was as though she thought that estimation bore no intimate relation to solving the ordinary run of mathematical problems. In contrast, the Framework argued that ". . . estimation activities should be presented not as separate lessons but as a step to be used in all computational activities" (CSDE, 1985, p.4).

I wondered what students made of this. They appeared to accept the lesson as reasonable. No one complained about the lack of comprehensible data, which they might have done if they were used to such data. No one said that they had done it differently some other time and that this didn't make sense. That could mean that the other lessons on estimation conveyed a similar impression, or it could mean that students were doing as they had been told because they had so often been told to do so, or because they had a visitor. Or it may mean only that students took nothing from the lesson. Schools present many mystifying examples of adult behavior that children learn to simply accept, and this may have been such a case.

Was this teaching math for understanding? From one angle, it was. Mrs. O taught a novel and important topic, specifically intended to promote students' sense-making in arithmetic. It may have done that. But from another angle it was not. For the problem was framed so that many students could not bring mathematical evidence to bear on it and had little basis for making reasonable estimates. These alternatives are not mutually exclusive. This bit of teaching could have promoted more understanding of mathematics along with more misunderstanding.

New Organization and Old Discourse

Mrs. O's class was organized to promote "cooperative learning." The students' desks and tables were gathered in groups of four and five so that they could easily work together. Each group had a leader to help with various chores, and instructional materials often were managed by groups rather than individually. The new Framework approved: "To internalize concepts and apply them to new situations, students must interact with materials, express their thoughts, and discuss alternative approaches and explanations. Often, these activities can be accomplished well in groups of four students" (CSDE, 1985, p.16).

Hence cooperative learning groups are seen as vehicles for a new sort of instructional discourse, in which students would do much more of the teaching. Students would learn from their own efforts to articulate and explain ideas, and they would learn from their mates' ideas. The Framework explains: "Students have more chances to speak in a small group than in a class discussion; and in that setting, some students are more comfortable speculating, questioning, and explaining concepts in order to clarify their thinking" (CSDE, 1985, pp. 16-17). Mrs. O's class was spatially and socially organized for such learning, but the class was conducted in a highly structured and classically teacher-centered fashion. The exchanges were either between the teacher and one student or choral responses to the teacher's questions. No student ever spoke to another about mathematical ideas, as part of the public discourse of the classes that I observed. Nor was such conversation ever encouraged by the teacher. Indeed, Mrs. O specifically discouraged students from speaking with each other in her efforts to keep the class orderly and quiet.

Still, the small groups were used for some instructional purposes. In one class that I observed, Mrs. O announced a "graphing activity" about mid-way through the math period. She wrote across the chalk board, at the front of the room, "Letter to Santa?" Underneath she wrote "Yes" and "No." Then she told the children that she would call on them by groups to answer the question. If she had been following the Framework's injunctions, she might have asked each group to tally its answers to the question, asked each group to figure out whether it had more "yes" than "no" answers, or the reverse, and asked each group to figure out how many more. Then she might have had each group contribute its totals to the chart at the front of the room. This would not have been the most challenging group activity, but it would have meaningfully used the small groups as agents for working on this

(Continued on page 44)

REVOLUTION IN ONE CLASSROOM

(Continued from page 23)

bit of mathematics.

But Mrs. O used the groups only to call on individual children. She asked individuals from each group to come to the front and put their entry under the "Yes" or "No" column, exhausting one group before going on to the next. The groups were used in a socially meaningful way, but there was no mathematical discourse within them.

Was this teaching for understanding? Mrs. O did use a new form of classroom organization that was designed to promote collaborative work and broader discourse about academic work. She did employ the small groups consistently during my visits. The children seemed quite familiar with procedures and worked easily in this organization. She also used the groups to distribute and collect instructional materials and to dismiss the class for lunch and recess (she let the quietest and tidiest group go first). Moreover, she referred to her classwork as "cooperative learning" and used the organization for some regular features of classroom work. When I mentally compared her class with others I had observed in which students sat in rows and in which there was only whole group or individual work, her class seemed really different. But she filled the new social organization with old discourse processes that effectively frustrated the sort of cooperative learning that the Framework's authors had envisioned. I asked if she ever used the groups for discussions and that sort of thing; she said that mostly she worked in the ways I had observed.

REPRISE

I have emphasized certain tensions within Mrs. O's classes, but these came into view partly because I crouched in her class with one eye on the Framework. Other observers might not have noticed them, for Mrs. O's lessons went quite smoothly. She and her students were well used to each other, and the contrary elements of instruction that I have highlighted did not jar the class. On the contrary, students and teacher acted as though these lessons made perfect sense. Features of instruction that seemed at odds analytically appeared to co-exist nicely in practice.

One reason for this lay in the classroom discourse. Mrs. O never invited or permitted broad participation in mathematical discussion. She held most exchanges within a recitation format; she initiated nearly every interaction, and the students responded. They complied. After all, most second graders want to please their teacher, and compliance is easier than initiation. In consequence, the discourse was very familiar to members of the class, almost ritually so. The calendar exercises that I observed were so familiar that students often gave the answers before she asked the questions. Most of the class participated, but they did so on a narrow track in which she maintained control of direction, content, and pace.

In contrast, the Framework argued that children need to express and discuss their ideas in order to understand the material on which they are working (CSDE, 1985, pp. 14, 16). But the discourse in Mrs. O's class discouraged students from reflecting on mathematical ideas or from sharing their puzzles with the class. Attention was focused instead on successfully managing a highly structured set of activities. This restricted even the questions and ideas that could occur to students, for thought is created, not merely expressed, in social interactions. Mrs. O employed a curriculum that sought to teach math for understanding, but she kept evidence about what students understood from entering the classroom discourse. The discourse remained smooth partly because so much possible roughness was choked off at the source.

Another reason for the lesson's smoothness lay in Mrs. O's knowledge of mathematics. Though she plainly wanted her students to understand this subject, she did not know mathematics deeply or extensively. She had taken one or two courses in college, and reported that she had liked them; but she had not pursued the subject further. Moreover, Mrs. O knew mathematics as a fixed body of truths, rather than as a particular way of framing and solving problems. Questioning, argument, and explanation seemed quite foreign to her. She worked hard to make the fixed truths accessible to her students, using a new curriculum that promised to embody mathematical ideas and operations in concrete materials and physical activities. This struck her (and many other teachers today) as a great improvement on words and sheets of numbers. But neither Mrs. O nor *Math Their Way* saw mathematics as a source of puzzles, as a terrain for argument, or as a subject in which questioning and explanation were key elements of learning—all ideas that are plainly featured in the Framework (CSDE, 1985, pp. 13-14). Lacking a sense of importance of explanation in mathematics, she simply slipped over many opportunities to elicit it, unaware that they existed. Because her conception of mathematical understanding was so limited, she could "teach for understanding," with little sense of how much remained to be understood, how much might be incompletely or naively understood, and how much might still remain to be taught. Working as she did near the surface of the subject, many elements of understanding and many pedagogical possibilities remained invisible. Mathematically she was on thin ice. But she did not know it and so skated smoothly on with great confidence.

Mathematically she was on thin ice.

In a sense, then, the tensions that I observed were not there. Though real enough in my view, they did not enter the public arena of the class. For they were kept hidden by the nature of the class itself. Mrs. O's modest grasp of mathematics, her limited conception of mathematical understanding, and her close management of classroom discourse simply obliterated many potential sources of roughness in the lessons. Had Mrs. O known more math and constructed a somewhat more open discourse, her class would not have run so smoothly. Some of the tensions that I noticed would have become audible and visible. Things would have been rougher, potentially more fruitful, and vastly more difficult.

PRACTICE AND PROGRESS

Is Mrs. O's mathematical revolution a sign of progress or confusion? Does it signal an advance or a setback for the latest new math? It probably is unwise to sharply distinguish progress from confusion when considering such deep change in instruction as reformers press today. For the teachers and students who try to carry out such change cannot simply shed their old ideas and practices like a shabby coat and slip on something new. Inherited ideas and practices are all that teachers and students know, even as they begin to know something else. As they reach out toward a new instruction, they do so with their old instructional practices. Their past is their only path to the future. Mixed practice and confusion, therefore, seem essential to progress.

This point often goes unnoticed by those in the throes of change, as well as by those who promote it. The changes in Mrs. O's teaching that seemed paradoxical to me seemed revolutionary to her, and I do not think she was deluded. She saw certain crucial limits of her early emphasis on computation and memorization and was convinced that her classes have greatly improved. She contended that her students now understood and learned much more math than their predecessors had a few years ago. She even asserts that this has been reflected in their achievement test scores. I have no direct evidence of these claims. But when I mentally compared this class with others that I have seen, in which instruction consisted only of rote exercises in manipulating numbers, her claims seemed entirely plausible. Many traditional teachers viewing her classes today would also think they were revolutionary.

But all revolutions preserve large elements of the old order as they invent new ones, if only because everything cannot change at once. One continuing element in Mrs. O's practice was a conception of mathematics as a fixed body of knowledge. Another was a view of learning mathematics as getting the right answers. She said that math had not been a favorite subject in school and that she had only learned to do well at it in college. When I asked her how that had happened, she said, ". . . I found that if I just didn't ask so many 'why's' about things that it all started fitting into place. . . ." Mrs. O learned to do well at math by avoiding exactly the sort of questions that the Framework associates with understanding mathematics. She noted that her view of math has not changed since college.

Another persistent element in her practice was "clinical teaching," that is, the California version of Madeline Hunter's Instructional Theory Into Practice (ITIP). This approach stresses the importance of structure in lessons and is associated with a rigid, sonata-form pedagogy, close teacher control, brisk pacing, and highly structured recitations. ITIP appears to have played an important part in Mrs. O's own education as a teacher, and she has been encouraged to persist with it. Both her principal and assistant principal at the time were devotees of Hunter's method and vigorously promoted it in the school. I asked all three of them whether clinical teaching worked well with the Framework. None saw any inconsistency, saying emphatically that the two innovations were "complementary." Yet as ITIP was realized in Mrs. O's class, it cut across the grain of the Framework. For she took clinical teaching as a license to rigidly limit discourse, to closely control social interaction, to focus the classroom on herself, and to hold instruction to relatively simple objectives.

Is Mrs. O's mathematical revolution a sign of progress or confusion?

If Mrs. O's past affected the changes in her practice, it also affected how she saw them. In the spring of 1989, I asked where her math teaching stood. She thought that her revolution was over. Her teaching had changed definitively: She had arrived at the other shore. In response to further queries, Mrs. O evinced no sense that there were areas in her math teaching that needed improvement. Nor did she seem to want guidance about how well she was doing or how far she had come.

There is an arresting contrast here. From an observer's perspective, especially one who had the new Framework in mind, Mrs. O looked like a teacher in transition. On this view, she might be imagined near the beginning of growth toward new math teaching. But the matter looked quite different to Mrs. O, who considered things in light of her past work. She saw herself as a teacher who had made a great transition and mastered a new practice.

Which perspective is most appropriate—Mrs. O's or the hypothetical observer's? This is a terrific puzzle. One wants to honor this teacher, who has made a serious and sincere effort to change, and who has changed. But one also wants to honor efforts to achieve greater intelligence and humanity in mathematics instruction.

We might begin by noticing that Mrs. O had only one perspective available. No one had asked how she saw her math teaching, in light of the Framework, nor had she been offered opportunities to view other sorts of teaching. If no one in California education had seen fit to ask her the question and help her to figure out answers, could we expect her to have asked and answered it all alone?

If math teaching is half as deficient as reformers say, then few teachers would know enough to raise many fruitful questions about their practice. Mrs. O's own lessons quite effectively protected her from experiences that might have provoked such questions. But even if such questions were somehow raised for Mrs. O and other teachers, would they know enough to frame appropriate answers? How could teachers be expected to assess their own progress in inventing a new sort of instruction if their teaching is half as dismal as reformers suggest?

One can imagine arrangements that would help teachers to learn more about math teaching and how to think about it. But California's budget for professional development is painfully modest just now. Lacking such assistance, could teachers assess their progress as though they had access to thoughtful commentary, when in fact most had none?

Even if Mrs. O had had such assistance, she would still have had to build on her past practices as she changed, like any practitioner. Hence her view of how much she had accomplished would be tied to her subjective experience of change. Teachers whose practice is very traditional would most likely think that their first steps—that would seem small to an observer—were quite large. For from a perspective still rooted mostly in a traditional practice, such modest changes would be immense. Such teachers might come to regard them as small only if they took some larger steps later on and consequently gained a different perspective. Of course, we might expect more from teachers who had a good deal of help in thinking about teaching in some active discourse about their work, in which questions were asked and answered from a variety of perspectives. For those teachers would have more resources for change, unlike colleagues who had been left to figure things out for themselves.

From this perspective, Mrs. O's progress seems remarkable.

What would it take to make such assistance available to teachers? And to help teachers pay constructive attention to it? Neither query has been given much attention, either in efforts to change instruction or in efforts to understand such change. But without such help, it is difficult to imagine how Mrs. O and many other teachers could make the changes that reformers now invite.

POLICY AND PRACTICE

Mrs. O's math classes suggest a paradox. On the one hand, policy is the key to changing practice. For new instructional policies illuminate deficiencies in teaching and learning and provide impetus for change. From this perspective, teachers are the problem, for it is their mechanical and modest knowledge of mathematics that impedes progress. But teachers also are the chief agents of any new instruction, because few students will learn a new mathematics unless teachers teach it. The new policy seeks great changes in knowledge, learning, and teaching, yet these are intimately held human constructions. They cannot be changed unless the people who know, teach, and learn want to change, take an active part in changing, and have the resources to change.

How can practice be improved if the chief change agents are also are the problem to be corrected? This puzzle is worth noticing partly because so much instructional policy making seems to ignore it. Many policies that seek fundamental instructional reform look as though their authors believed that students and teachers would change if they simply were told to do so. New goals are articulated, and exhortations to pursue them are issued. Sometimes new materials are provided. Another reason to notice the paradox is that the instructional changes reformers seek are immense. If the recent reforms are to succeed, students and teachers must not simply absorb a new "body" of knowledge. Rather, they must acquire a new way of thinking about knowledge and a new practice of acquiring it. They must cultivate strategies of problem solving that seem to be quite unusual among adult Americans. They must learn to treat knowledge as something they construct, test, and explore, rather than as something they absorb and accumulate. Additionally, and in order to do all of the above, they must un-learn much of what they know, whether they are second graders or veteran teachers. Their extant knowledge may be naive, but it often works. A few can learn these things easily, and some even seem to pick it up on their own. But many very able learners have great difficulty, and so prefer the traditional sorts of learning that reformers reject.

Learning a new mathematics is much more formidable for teachers than students, for they must learn how to teach anew while relearning what to teach. And they must un-learn the mathematics and teaching practices that they have used for decades.

Mrs. O was not taught about the new Framework in a way that recognized these difficulties. Instead, the California state education department taught her about the new math using roughly the same traditional pedagogy that it criticized in the Framework. Like students in many traditional math classrooms, she was told to do something. She was told that it was important. And a synopsis of what she was to learn was provided in a text. The state advanced an instructional revolution, but it used an old pedagogy to do so. If, as the Framework argues, it is implausible to expect students to understand math simply from telling it to them, why is it any less implausible to expect changes in teaching to result simply from telling teachers to change? From this perspective, Mrs. O's progress seems remarkable.

What more might it take to support major instructional change? It is no answer to the question, but I note that few people in Mrs. O's vicinity seemed to be asking that question, let alone taking action based on some answers.

This is no argument against the changes that reformers press. The revised California Mathematics Framework offers a bold and ambitious vision of mathematics instruction, one that took imagination to devise and courage to pursue. Yet this admirable initiative has done little to augment teachers' capacities to realize the vision. The new Framework, for instance, had barely been announced in her school. She knew that it existed but was not sure that she ever had read it. She knew that the principal had a copy and that the new text series had been written in light of the Framework. She had attended a publisher's workshop on the new text and found it informative. She also had studied the text and the teacher's guide. But like many teachers in her district, she used the new book only a little, preferring *Math Their Way*. The state education department also supported a network of teacher development projects, mostly in universities, that offered math workshops for teachers. But

Ph.D. or Ed.D.

FOR THE ACTIVE PROFESSIONAL

- Complete your doctorate in a self-paced, personalized, accredited program without interrupting current work patterns.
- Address significant issues in conjunction with your professional responsibilities.
- Work with nationally recognized faculty toward your doctorate.
- Prerequisite: Masters or equivalent.

Call for information concerning programs in your area.

1-800-444-6795

WALDEN UNIVERSITY

☑ **Yes, please send a catalog to:**

Name

Address

City, State, Zip

Phone ( )

MAIL TO: Walden University
801 Anchor Rode Dr., Naples, FL 33940

WRITE US!

We welcome comments on *American Educator* articles. Address letters to: Editor, American Educator, 555 New Jersey Ave., N.W., Washington, D.C. 20001. Letters selected may be edited for space and clarity.

there are only a handful of these projects compared with the tens of thousands of teachers in California, and most workshop sessions are brief. A few project staffers follow teachers back into school and offer support for change, but most do not. To the extent that there was support or guidance for change in Mrs. O's practice, it was local, but there was precious little of that.

Hence the changes in Mrs. O's practice were at best weakly guided and supported by the new policy. From one angle, this seems admirable. Mrs. O has had considerable discretion to change her teaching, and she has done so in ways that seem well adapted to her school. Though I call attention to the mixed quality of her teaching, her superiors celebrate her work. But if we take seriously reformers' arguments about the importance of mathematics and the need for a new mathematical pedagogy, then Mrs. O's situation is troublesome. When I observed what I report here, there seemed little chance that she would be helped to struggle through to a more complex knowledge of mathematics and a more complex practice of teaching mathematics. And if she cannot struggle through, how can she better help her students to do so? The recent reform movement has vastly expanded Mrs. O's obligations in teaching mathematics, without much increasing her resources for meeting those obligations. Ambitions for reform have continued to escalate as state and local budgets contract.

That collision between ambitions and resources may turn out to be crippling. Researchers and other commentators on education have begun to appreciate how difficult it is for many students to achieve deep understanding of a subject. This appreciation is at least occasionally evident in the rhetoric of reform. But so far, there is little appreciation of how difficult and costly it will be for teachers to learn new practices in which students are competently guided toward deeper understanding.

Acknowledgment

This work, of which this research is part, has been sponsored in part by three OERI-funded research centers—the Center for Research on Teacher Education, the Center for the Learning and Teaching of Elementary Subjects, and the Center for Policy Research in Education. The particular study reported here was funded by the Office of Educational Research and Improvement, Grant No. R117 P8000 4, U.S. Department of Education. The views expressed in this article do not necessarily represent the position, policy, or endorsement of the Office or Department. The essay was improved by comments and other assistance from my colleagues in the study: Deborah Ball, Ruth Heaton, Penelope Peterson, Dick Prawat, Ralph Putnam, Janine Remillard, Nancy Jennings, and Suzanne Wilson. Comments from Magdalene Lampert and Larry Cuban also were most helpful.

REFERENCES

Baratta-Lorton, M. (1976). *Math Their Way.* Boston: Addison-Wesley.

California State Department of Education. (1987). *Mathematics Model Curriculum Guide.* Sacramento, CA: Author.

California State Department of Education. (1985). *Mathematics Framework for California Public Schools, Kindergarten through Grade Twelve.* Sacramento, CA: Author.

Cuban, L. (1986). *How Teachers Taught.* New York: Longman.

Cuban, L. (1986). *Teachers and Machines.* New York: Teachers College Press.

Cohen, D. K. (1989). Teaching Practice: Plus ca Change. In P. W. Jackson (Ed.), *Contributing to Educational Change: Perspectives on Research and Practice* (pp. 27-84). Berkeley, CA: McCutchan.

diSessa, A. (1983). Phenomenology and the Evolution of Intuition. In D. Gentner & A. L. Stevens (Eds.), *Mental Models* (pp. 267-298). Hillsdale, NJ: Erlbaum.

Gross, N., Giaquinta, J., & Bernstein, M. (1971). *Implementing Educational Innovations.* New York: Basic.

Lampert, M. (1988, January). *Teachers' Thinking about Students' Thinking about Geometry: The Effects of New Teaching Tools.* Cambridge: Educational Technology Center.

Lipsky, M. (1980). *Street Corner Bureaucracy.* New York: Sage.

Rowan, B., & Guthrie, L. F. (1989). The Quality of Chapter 1 Instruction: Results from a Study of Twenty-four Schools. In R. Slavin, N. L. Darweit, N. A. Madden (Eds.), *Effective Programs for Students at Risk* (pp. 195-219). Boston: Allyn & Bacon.

Welsh, W. W. (1979). Twenty Years of Science Curriculum Development: A Look Back. *Review of Research in Education, 7,* 282-306.

6 EFFECTIVE DISSEMINATION STRATEGIES

Audience:

- Developers and trainers of exemplary science and mathematics practices and programs.

Desired Outcomes for Participants:

- To identify effective dissemination strategies.
- To develop a dissemination plan.
- To choose among alternative formats for awareness materials.
- To evaluate awareness presentations.
- To develop strategies for hosting visits by potential adopters.

Materials:

- **Transparencies:**
  - *Strategies of Effective Disseminators* (6-7)
  - *Strategies for Overcoming Obstacles to Promoting Science and Mathematics Programs* (6-8)
  - *Me as a Promoter?* (6-9)
  - *Kinds of Awareness Materials* (6-10)
  - *Outline for Awareness Presentation* (6-11)
  - *Presentation Enhancers* (6-12)
- **Handouts.**
  - *Strategies of Effective Disseminators* (6-13 and 6-14)
  - *Awareness Brochures* (6-15 through 6-17)
  - *One-Page Program Descriptions* (6-18)
  - *Detailed Program Descriptions* (6-19 and 6-20)
  - *Press Releases* (6-21 through 6-23)
  - *Awareness Materials Evaluation Form* (6-24)
  - *Outline for Awareness Presentations* (6-25 and 6-26)
  - *Evaluating an Awareness Presentation* (6-27)
  - *Demonstration Site Visits* (6-28)
  - *Learning Activities for Demonstration Site Visits* (6-29)
- **Reading:**
  - "What Is a Dissemination Plan?" by Donald P. Ely and A. Michael Huberman, from *User-Friendly Handbook for Project Dissemination: Science, Mathematics, Engineering and Technology*

Education. Washington, DC: National Science Foundation, 1993, 7-14.

- Sample awareness materials (brochures, flyers, videos, etc.)
- VCR (if sample awareness materials include videos) and monitor
- Overhead projector and screen
- Newsprint, easel, markers, tape, blank paper, and pens or pencils

Time Required: Three hours

Facilitator's Notes: This activity has two purposes. The first is to help participants examine the strategies they use for dissemination and consider additional strategies as they focus on their own planning. The second purpose is to work in depth on the first type of dissemination – spread. In doing so, participants consider how they can best promote their programs and practices, representing them in clear and compelling ways.

One note about awareness materials: try to include in the samples you provide as many nonprint materials as possible. Although print materials are still the least expensive to produce and the easiest to distribute, they are increasingly being replaced by video, videodisk, other software, etc. To the extent that you can push participants to consider other forms for awareness materials, this activity will have more potential to stimulate them to be creative and try something new.

This activity is best done with individuals who have their own programs (or those developed by others) to actively disseminate. Otherwise it is difficult (or irrelevant) for them to spend time building a dissemination plan and critiquing their awareness materials. As always, learning best occurs when participants can get actively involved in activities relevant to their own lives.

In a similar vein, we greatly encourage you to ask participants to bring their own awareness materials. You will notice in Process Step 6, when they review the sample awareness materials you have provided, they also have the opportunity to examine those they have brought. Again, it will be more meaningful if the activity can connect directly to their own work.

We also encourage you to think about how the criteria generated in **Activity 7: Making Good Choices among Successful Practices** – those a group of school or district people will use to select a program – should influence the nature of awareness materials analyzed in this activity. Depending on your participants and the ways they intend to use what they are learning, you may want to integrate the two activities in some way.

Process:

1. Ask participants to imagine that they are charged with helping a school or district find, learn more about, select, and implement an exemplary science or mathematics program, practice, or idea. Ask them to share with a partner some key strategies they would use to ensure success. After five minutes, have the pairs join another pair to compare notes. Ask for each group of four to report out. Record on newsprint.

2. Explain that dissemination is a multistage process and that without going all the way to implementation support, they may arrive short of success. Distribute the handout **Strategies of Effective Disseminators (6-13 and 6-14)** and show the **Strategies of Effective Disseminators (6-7)** transparency, asking participants to work in their groups of four to compare their own strategies to those listed.

   After ten minutes, ask them to continue their dialogue concentrating on the following questions:

   - With which of these strategies have you been most/least successful?
   - What are some obstacles to promoting interest for new science and mathematics programs, practices, or ideas?
   - How do you establish commitment for your project?
   - What are the most effective materials for promoting your project?
   - What elements of good professional development do you use when disseminating your project?
   - What mechanisms do you establish for responding to problems in a timely fashion?
   - How do you know that you have achieved the purpose of your dissemination?

3. After 20 minutes, ask the groups to report out the key points of their discussions on newsprint. Ask the whole group to identify patterns and insights across groups.

   Point out that the first two strategies involve what might be called "promoting." Note that educators never felt it was their place to "market" or promote their effective programs and practices; rather they spent their efforts being the very best teachers or creating the very best schools they could. Now, the mindset about such restrictions is changing – teachers and administrators not only *can*, but *must* help others use what they've found to be effective. They need to be leaders and, in effect, promoters and marketers of better ways to teach.

   Show the **Strategies for Overcoming Obstacles to Promoting Science and Mathematics Programs (6-8)** transparency and review its content, connecting to the newsprint. Ask the group if they have additions to suggest.

4. Point out that every promotional effort needs a person or group behind it. It's important that participants see themselves not only as good educators, administrators, etc., but as "promoters." Show the **Me as a Promoter? (6-9)** transparency and explain the "personality types" on the continuum.

   Have participants draw the continuum for themselves and place an "X" where they see themselves. Have them turn to a partner and share responses. Point out that a "can do" attitude about promotion can go a long way towards reaching those they most want to reach.

5. Explain that they will use what has been discussed so far to develop a plan for dissemination. Ask them to work in pairs or small groups; if people came together they should work together. Pass out the reading "What Is a Dissemination Plan?" and allow 45 minutes to work on the questions within the reading.

6. Outline the remainder of the session: It will focus on the first type of dissemination: spread. They will learn more about three ways to make people aware of new programs or practices – materials, presentations, and hosting site visits. They will have the chance to explore what works as well as examine their own promotional efforts.

   Show the **Kinds of Awareness Materials (6-10)** transparency and review the kinds of awareness materials. Distribute the four handouts dealing with awareness materials: **Awareness Brochures (6-15 through 6-17), One-Page Program Descriptions (6-18), Detailed Program Descriptions (6-19 and 6-20),** and **Press Releases (6-21 through 6-23)**. Ask participants to form groups of four. Have each person read a different handout and brief the group on it. Allow 15 minutes.

Meanwhile, set up the room with several stations, each with a different awareness material (brochure, flyer, video, press release, etc.). Put a stack of the handout **Awareness Materials Evaluation Form (6-24)** at each station.

After the small groups finish their briefings, have them rotate from station to station and use the **Awareness Materials Evaluation Form** to evaluate each sample material. Allow ten minutes at each station (or more, if the materials are complex or lengthy).

If participants have brought their own awareness materials, have them stay with their groups and use the **Awareness Materials Evaluation Form** to examine and discuss them. When they are finished, have groups share their observations, issues, and questions.

7. Ask participants to go back into their groups and come up with the essential elements and flow (sequence) of an awareness presentation for a new science or mathematics program or practice. After ten minutes, have the groups report out.

   Use the **Outline for Awareness Presentations (6-11)** and **Presentation Enhancers (6-12)** transparencies and distribute the handout **Outline for Awareness Presentations (6-25 and 6-26)** and have the groups compare this information with their prior discussion. Be sure to give examples of each of the **Presentation Enhancers**.

   Ask the groups to reflect on awareness presentations they have done. Distribute the handout **Evaluating an Awareness Presentation (6-27)** and have participants complete it on their own. Ask them to share their responses upon completion.

8. Ask participants to think about a visit to the site of a successful practice. What was most helpful to them in learning about the practice? Have them share and record responses on newsprint. Ask them to think about their concerns about hosting site visits; record some of their concerns on a separate piece of newsprint.

   Use the handouts **Demonstration Site Visits (6-28)** and **Learning Activities for Demonstration Site Visits (6-29)** for a discussion of this topic, paying special attention to the concerns that were generated. Where there is no specific strategy for dealing with a concern, discuss possibilities.

9. Have participants reflect back on what they have learned about dissemination. Give them a few minutes of reflective writing time to complete this stem: Ways that I can contribute to the dissemination of successful science and mathematics programs, practices, and ideas include. . . .

   You may want to use some of the guidelines from the "Leading Through Systems Thinking" article from **Activity 1: Framing the Dialogue Around Systemic Change** to generate dialogue around how they might do dissemination differently, using a systems thinking approach.

Additional References:

Ely, Donald P. and A. Michael Huberman. 1993. *User-Friendly Handbook for Project Dissemination: Science, Mathematics, Engineering and Technology Education.* Washington, DC: National Science Foundation.

Loucks, Susan F. 1983. *Planning for Dissemination.* Chapel Hill, NC: The Technical Assistance Development System, Frank Porter Graham Child Development Center.

STRATEGIES OF EFFECTIVE DISSEMINATORS

- Create awareness
- Establish commitment
- Provide implementation support via materials and training
- Solve problems and troubleshoot
- Monitor and evaluate

STRATEGIES FOR OVERCOMING OBSTACLES TO PROMOTING SCIENCE AND MATHEMATICS PROGRAMS

OBSTACLES	STRATEGIES
Requires change and risk — "What am I getting myself into?"	Spell out what's in it for them — innovative programs that impact student motivation and achievement
Not always recognized as a need — "This is the way I was taught and I learned it well."	Create urgency — not all students learn well the traditional way
Intangible product — not like a widget	Make it concrete — the realities of science and mathematics illiteracy
Return on investment of money, time, effort, and psychological anguish	Can't afford not to implement reforms
Learning science and mathematics is boring and unproductive	Prove otherwise through cutting edge inquiry/ problem solving-based learning
Interest (attending a workshop) vs. commitment (actually making changes)	Provide support needed for action-based change to occur

ME AS A PROMOTER?

PEACOCK	BALANCED	MOUSE
• Judgment of others • Self-righteous • I know the answers	• Knowledgeable • Care about customer and product • Transfer skills from science to business	• Low self-esteem • I don't know enough to sell • Who would want to buy something from me

KINDS OF AWARENESS MATERIALS

- Awareness/information brochure
- One-page program description
- Detailed program description
- Video
- List of services
- List of materials, equipment, and facilities
- Press release
- Other

OUTLINE FOR AWARENESS PRESENTATION

I. Our program is designed to . . .

1. Introduce self and program
2. Convey basic program information
3. Sample the program (optional)

II. When you decide to adopt the program . . .

4. Provide implementation requirements
   - a. Training
   - b. Implementation support
   - c. Materials
   - d. Next steps

III. Remember that our program will . . .

5. Give conclusion
6. Ask for questions

Source: Materials developed by RMC Research Corporation, April 1994. Reprinted with permission.

PRESENTATION ENHANCERS

- Visuals
- Quotes
- Humor
- Props
- Activities
- Stories
- Other

STRATEGIES OF EFFECTIVE DISSEMINATORS

Create awareness

- Awareness materials should answer the questions: "What is it?" and "How will it affect me?"
- At this point there is no need for a lot of detail about organization and management, nor about all the results you have achieved.
- Use awareness materials to create an image of what the program looks like where it has been used.

Establish commitment

- Once people know what your program is and how it will affect them, they need to know what's in it for them to use it.
- Identify the benefits derived from using your program or its components. Show others the problems you have solved.

Provide implementation support via materials and training

- While providing materials alone does not effectively disseminate a program, materials can be vital to its use.
- Materials that are particularly useful are ones that show how to implement a particular program such as instructional manuals, teacher's guides, etc.
- Instructional materials must be clear, free of jargon, and comprehensive.
- Materials must be bias free and culturally sensitive, using illustrations that include people of different sexes, races, and other areas of diversity.
- Training should include step-by-step procedures for using your program.
- Provide information, demonstration, hands-on practice, and opportunities to discuss with others and plan for direct application back in the home settings.

Source: Reprinted with permission of the author from *Planning for Dissemination* by Susan F. Loucks. ©1983, 3-5.

STRATEGIES OF EFFECTIVE DISSEMINATORS (continued)

- One-shot training is rarely successful. People must try out new behaviors a few at a time and be able to come back periodically to solve problems and learn more. Divide training into segments of one or two days a month for three months. Or, a large initial session can be followed by regular individual and small group consultations over several months.

- Without follow-up training, behaviors that don't seem to work the first time will be discontinued or changed so radically from what was intended that they may do more harm than good.

Solve problems and troubleshoot

- Build in a plan for solving problems. You might return periodically to the new site to help users solve problems they might be having with the program. Often this can be done simply by visiting, observing, and holding informal voluntary sessions for staff. Never underestimate the benefits of encouragement.

Monitor and evaluate

- Monitoring helps ensure that a model program is being implemented as intended, or that the adaptations that are made are beneficial ones. Evaluate implementation first (i.e., to what extent are critical components in place and what improvements might help?) Only when the program is being used routinely should impact on learners be the focus of evaluation.

AWARENESS BROCHURES

Audience

Potential adopters, other intermediaries, important district officials

Purpose

To provide basic information about an educational program to as many different types of people as possible – teachers, administrators, school board members, parent coordinators; to describe a regular project activity or to advertise a special project-sponsored activity or event; to identify as potential adopters and/or participants those who request further information or who indicate interest in a project-sponsored activity.

Content

A brochure that successfully provides basic information about a project and its program to an extended audience will:

- be as attractive and eye catching as possible and generate interest in the program;
- not assume that the audience has a prior interest in the program; and
- be written so that the name of the program and its logo, if any, are emphasized and will be remembered.

It will also highlight:

- target audiences: who benefits by the program
- program goals: why the program was developed; what it intends to accomplish
- basic features: content area or management concern; objectives within this area or concern; materials and methods used to attain these objectives; staff involved in an adoption; others affected by adoption
- project history: when and where the program was developed; by whom; sources of developmental funding; sites, staff, and learners involved
- evaluation results: format and date of testing; tests used; results indicating learner gains, stated in lay terms

Source: Materials developed by RMC Research Corporation, April 1994. Reprinted with permission.

AWARENESS BROCHURES (continued)

- adoption requirements: what adopters must provide, obtain, and do to use the program with similar success

- services available to potential adopters (for example, needs assessment, assistance in writing funding proposals) and to adopters (for example, preservice training, follow-up inservice training, monitoring, evaluation, other consulting)

- contact person, complete mailing address, and telephone number

- copyright: it must not contain picture or copyrighted material for which releases have not been obtained

A brochure can also be used to advertise special events or publicize regular program activities. In either case, present details concisely, accurately, and interestingly. Any special event or regular activity announcement should also contain a brief program overview.

One way to identify potential adopters or participants is to design a portion of the brochure for use as a tear-off return mailer. Returned mailers can be used to assess the appeal of the program or the effectiveness of the brochure. Coding brochures to identify the activity where they were used (if distributed by mail) can help in assessing the cost effectiveness of that strategy. Returned mailers can also form the basis of future mailing lists.

Format

Many variations exist, but the least expensive and most common sizes are 8-1/2 x 11" (standard business size) or 8-1/2 x 14" (legal size) sheets, 20-pound paper or heavier, coated or bond, folded two or three times to 8-1/2 x 3-1/2" to fit a #10 (standard business size) envelope.

If a brochure is mailed without an envelope, one of the panels must be set aside for the address. Include the project return address in the upper left hand corner of this panel, area for the address or an address label in the center, and postal indicia or space for a postage stamp or postage meter imprint in the upper right hand corner. Making the brochure a self-mailer saves the cost of envelopes and time spent stuffing them for project staff and others who distribute information.

If a brochure is designed to obtain requests for further information about the project, specific aspects of the program, or project-sponsored activities (awareness presentations, site visitations, training workshops) or to preregister participants for special events, paper weight must meet Postal Service requirements for post cards (currently cover stock weight). A panel no smaller than 3" (regulation Postal Service size for post card) should

AWARENESS BROCHURES (continued)

contain respondent options on one side and project mailing address on the other; if return postage is paid by the project, include postal indicia in upper right hand corner of address side of return card.

Professional graphic artist recommended for layout.

Life expectancy

One year for an all-purpose awareness brochure. (As your dissemination effort is refined, you may need to review the brochure less often.) Limited to date of event for a special event brochure.

Distribution

Varies with purpose of brochure. An all-purpose brochure may be distributed:

- to education association officials and those who requested information: by mail;
- to visitors, participants in project-sponsored activities, awareness conference participants, parents, and community members: in person;
- to other potential adopters: through intermediaries, including federal and state coordinators, department of education officials; and
- indirectly, as a hand out at conferences and workshops project staff do not attend.

If the brochure describes a regular project activity or a special event, it is best distributed directly, by mail, to a predetermined list of potentially interested people. By supervising your own distribution, you will know that intended participants receive timely notice.

Quantity

Varies with number of projected activities, availability of low-cost printing facilities to handle reruns, potential time delays involved in securing permission to reprint and scheduling printer, and time remaining before next update.

ONE–PAGE PROGRAM DESCRIPTIONS

Audience

Potential adopters, facilitators, other intermediaries, important district officials

Purpose

To give interested groups a concise overview of an educational program.

Content

Draft a one-page description highlighting target audience; program goals; project philosophy, history, and organization; program structure, materials and methods; evidence of program effectiveness; implementation requirements; financial requirements; services; contact person, address, and telephone number.

Format

One 8-1/2 x 11" sheet. Display project title and logo. Back of sheet can be used for other information, such as a list of materials or demonstration sites. Project stationery can be used if appropriate. Can be typewritten or typeset, reproduced by office copier or offset printing. Pay attention to quality of reproduction as recipients often make copies.

Life expectancy

One year, or as changes require.

Distribution

To potential adopters: in person or by mail.

Quantity

Two hundred copies, until demand can be judged and revisions made as determined by use.

Source: Materials developed by RMC Research Corporation, April 1994. Reprinted with permission.

DETAILED PROGRAM DESCRIPTIONS

Audience

Potential adopters who express serious interest

Purpose

To provide a comprehensive description of the project and detailed information on steps involved in adoption.

Content

Content and organization is similar to awareness brochure and one-page description, but information is more detailed. Additional topics to include:

- a concise summary of project objectives and activities
- intended outcomes for adopters
- project-developed criteria for selecting adopters
- a comprehensive list of personnel required for adoption
- a detailed breakdown of steps involved in adoption, with time required for each
- guidelines for estimating costs and preparing a budget
- a comprehensive list of required and optional material, equipment, and facilities needed for adoption

One double-spaced page for each topic.

To avoid having to revise and reprint the booklet, do not include costs, which often change.

Format

8-1/2 x 11" sheets, or 11 x 17" sheets folded to that size, with a cover of heavier stock, stapled or saddle stitched. For a smaller book, use 8-1/2 x 14" or 11 x 17" sheets and reduce to 8-1/2 x 11" format or smaller. Display project title and logo prominently. May be typewritten, typeset, or typewritten with typeset heads and reproduced by office copier or offset printing. If expense is no object, informative photos and other well-produced graphics can be included.

Source: Materials developed by RMC Research Corporation, April 1994. Reprinted with permission.

DETAILED PROGRAM DESCRIPTIONS (continued)

Life expectancy

Indefinite. Basic features of program and requirements for adoption should not change much. A first version should be prepared as a trial document; reviewers' comments should be used to prepare the final version.

Distribution

To potential adopters: in person or by mail.

Quantity

Depends on several factors: conditions and activity in your region, planned use for the booklet (whether to be mailed or carried to conferences as a handout). Two hundred copies is a safe preliminary estimate.

PRESS RELEASES

Purpose of the press release

The press release is a useful way to disseminate a small amount of information to a large number of people. The nature of the press release does not lend itself to sharing detailed or complex information targeted at a very select group of people, but is often a good way to generate interest or share some information at an almost negligible cost.

Press releases can be sent to local newspapers, radio, and television stations (both commercial and public), and professional associations that sponsor newsletters. The media you choose, however, should be appropriate in terms of the content and purposes of the press release. For example, announcing an open house to demonstrate a new technology in the schools would probably be appropriate for a local newspaper, radio, or television station. It would not be appropriate for a professional newsletter distributed across the country or for a television station serving a major metropolitan region outside of your local area. The press release might be appropriate for a newspaper serving a large metropolitan area adjacent to your location, but only if the newspaper is distributed in your area and also prints special local interest sections.

Preparing the press release

Before actually writing the release, determine the target audience and why you want them to have this information. Then, identify the potential media sources for the press release. Once you have established the potential sources for distribution, try to determine which one(s) will reach the greatest number of your intended audience. After that has been established, you will have a better idea of where to submit the press release.

At this point, to save some time and effort, contact the intended source(s) for distribution of the press release to find out whether they might, in fact, accept the kind of information you intend to submit. If so, ask whether they use a certain format, the maximum length of the release, deadlines for submission, and the name of the person who should receive the release.

Format. If there are no particular directions for the format, use the following generally acceptable guidelines:

- In one corner of the first page, identify the source giving out the press release (e.g., title of the project, organization) and the date it was written.

Source: Materials developed by RMC Research Corporation, April 1994. Reprinted with permission.

PRESS RELEASES (continued)

- If there is a specific date by which the item should be released, specify this date in the other corner of the first page (e.g., Release by 10/19/98).
- Clearly identify the person to be contacted for further information, including a telephone number.
- Give the release a short title which is descriptive of the content.
- Complete sentences and paragraphs on a page. If the last part of a sentence of paragraph does not fit on a page, move the entire paragraph to the next page.
- If the release has to be continued on another page, indicate that there is more to follow at the bottom of the page.
- At the end of the press release, clearly indicate that the material is finished.
- The press release should always be typed.
- Double space the text of each paragraph, triple space between paragraphs, and leave wide margins on both sides; type only on one side of the paper.
- Have more than one person proofread the final copy to ensure that there are no content or typographical errors. This will be especially important for dates, numbers, times, and so forth.

Writing Style. The writing style used in the press release is critical to the success in communicating the content to the intended audience. The style may also affect whether the release is even printed, as it is easier for an editor not to print a piece than to try to rewrite one with all kinds of problems. When writing the press release, keep the following guidelines in mind:

- Write to the intended audience. The content should be written in a manner that is easily understood by those reading the release.
- With the exception of submissions to professional newsletters, avoid technical terminology. If uncommon terms are impossible to avoid, define them in the text.
- Follow standard journalistic procedure. Avoid lengthy sentences, unnecessary words, and long, drawn-out paragraphs. Two to four short sentences in a paragraph is about right. Be concise.

PRESS RELEASES (continued)

- Get right to the point. State the most important information as close to the beginning of the release as possible. Place the least important information at the end of the release.
- Be accurate. Double check any facts, figures, or quotes.
- If some type of numbers are included (e.g., test scores, cost figures), make sure they are clearly explained and not open to misinterpretation.

After the press release has been written, have the material reviewed by someone else who is familiar with the content and by a person who is representative of the target audience. Use these reviews to make sure that the release clearly communicated the information. If necessary, revise any unclear sections and have the material reviewed again.

Submitting the press release

There are also a few points to keep in mind when submitting the press release. Timing is very important. Do not submit the release a long time before you would like to see it used. A meeting announced three months before it is held will probably be forgotten by the time the date occurs. Similarly, do not submit a release at the last minute. You may miss the required deadline and end up not having the release used at all.

Remember to submit the release directly to the person responsible for that type of material. Something sent to the wrong person may get lost on that desk or as it gets shuffled from one person to the next.

Finally, after a reasonable time, check with the responsible person to make sure that the release was received and whether there are any questions regarding the content. At that time you may also be able to determine whether the release will be used and, if so, when. Following up in this manner will probably increase the chance that the press release will be used.

AWARENESS MATERIALS EVALUATION FORM

Rate the following:

	Good	Fair	Needs Improvement	N/A
Purpose is clear				
Attractive layout				
Text is jargon free				
Name of program and logo are emphasized				
Target audience identified				
Program goals explained				
Program's basic features clear				
Program background included				
Evaluation results reported				
Services available listed				
Contact person named				

Overall assessment and comments:

OUTLINE FOR AWARENESS PRESENTATIONS

Definition: The purpose of the awareness presentation is to generate interest in your project. The audience is usually between 10 and 30 participants and may include teachers, administrators, and state officials. The typical time block is 50 minutes; your presentation should last approximately 40 minutes to allow for questions.

The following outline will assist you in preparing by ensuring that all points are covered.

Part One: "Our Project is Designed to . . ."

I. Introducing Yourself and Your Project

- Who are you and where do you come from?
- Why are you there?
- What is the purpose of the program?
- What will be covered during the next 40 minutes?

II. Conveying Basic Program Information

- What are the key elements?
- What is the target population?
- Why is the program unique?
- What problems will it help solve?
- Is the program based on a particular educational philosophy?
- How does the program work?

III. Sampling the Project *(Optional)*

Sharing teacher and/or student activities, curriculum examples, or teaching strategies

Source: Materials developed by RMC Research Corporation, April 1994. Reprinted with permission.

OUTLINE FOR AWARENESS PRESENTATIONS (continued)

Part Two: "When You Decide to Adopt the Program . . ."

IV. Adoption Requirements: Training, Implementation, Materials, and Next Steps

A. Training

- How long is the training?
- What happens during the training?

B. Implementation

- What arrangements must be in place (reading center, basal, computer, etc.)?
- Who must be committed to the project (single teacher, resource room, principal, superintendent)?
- How long does it take to fully implement the program?

C. Materials

- Are there training materials or curricula?
- What do they cost?

D. Adoption Next Steps

- Who should I contact?
- What are the next steps?

Part Three: "Remember That Our Project Will . . ."

V. Conclusion

- What should be remembered about this project?
- What materials will be available and how should they be shared?

IV. Questions and Answers

EVALUATING AN AWARENESS PRESENTATION

Rate yourself on an awareness presentation you have given on a scale of 1 to 5.

5 = Done very well; 1 = Needs improvement

Introduction: Did your introduction give a preview of the awareness presentation?

Purpose: Did you cover what problems and needs the practice solves/addresses?

Focus in: Did you address a few key points?

Benefits: Did you outline the advantages of the practice to potential adopters?

Proof: What evidence of effectiveness did you offer to the audience?

Responsiveness: How did you focus in on the audience; show enthusiasm; answer questions; etc.?

Conclusion: Did you review the key points of the presentation and next steps?

DEMONSTRATION SITE VISITS

Get ready

- What do the visitors want?
- What will the day look like?
- Who will participate?
- How should the staff and students prepare?

Provide visitor orientation

- Introduce visitors to appropriate participants.
- Provide a schedule.
- Prepare visitors to help them know what they will be seeing.

Managing the site visit

- Organize the visitors so they make the best use of their time.
- Check in from time to time to assess if their needs are being met.

Debrief

- Discuss insights and observations.
- Allow time for questions and to clarify how practices are implemented.
- Address next steps: Will the school send additional staff? Do they want a visitor from the model school to visit their school?

Source: Reprinted with permission of The NETWORK, Inc., from "Massachusetts Facilitator Project Protocols" by Denise Blumenthal. ©1987.

LEARNING ACTIVITIES FOR DEMONSTRATION SITE VISITS

Presentations

Orientation to the school's key practices and what to look for in the school.

Focused observation

Identify key classrooms and staff to demonstrate specific practices.

Mass participation

Encourage visitors to observe several classrooms to see instructional approach, climate, treatment of students, etc.

Informal meetings with staff

Organize time for visitors to meet with staff and ask questions about the school's success.

Shadowing

For specific practices, e.g., leadership and management, organize opportunities for visitors to stay with a specific person for a period of time to see how he/she handles "an ordinary day" at the school.

Planning session

Set up an opportunity for visitors to ask "What must we do to implement the practices seen today?" This session would include information about implementation requirements, costs, and timelines.

Source: Reprinted with permission of The NETWORK, Inc., from "Massachusetts Facilitator Project Protocols" by Denise Blumenthal. ©1987.

Reprinted with permission of the National Science Foundation from "User-Friendly Handbook for Project Dissemination: Science, Mathematics, Engineering and Technology Education" by Donald P. Ely and A. Michael Huberman. 1993, 7-14.

What Is a Dissemination Plan?

Like any organized procedure to accomplish specific results, a dissemination plan is deceptively simple. At first it may seem like a list of activities that have been organized to communicate a message to people who want (or ought) to receive it. However, a broader definition of dissemination is employed here. Greater complexity emerges and the need for a specific plan is evident. Before actually writing a plan, think about the following questions:

Why?	What is the **purpose** of the dissemination effort? What should happen as a result? What difference should it make? Why bother?
Who?	Who are the ultimate users of the product or practice? Should the users be reached directly or through intermediaries? How many people are in the **audience** and where are they located? Is there a secondary audience?
What?	What is the **content** that is to be disseminated? Is it new knowledge? What form is it in? If it is a product, does it require any type of training or assistance to ensure its proper use?
How?	What **means** or **media** could be used to disseminate the knowledge or products? Should several media be used? What are the most cost-effective ways to reach the defined audience? Are prospective users more likely to seek information from one source than another?
With What Consequences?	What does one expect to see if the dissemination is a **success**? Where will it make a difference? Are we fostering awareness? adoption? greater knowledge? enlightenment? enhanced capacity? changes in ongoing policies and practices? Without knowing which level of outcome we are after, it is practically impossible to make a dissemination plan.

Getting Started

There is no universal formula for successful dissemination. Still, if you can answer the why? who? what? etc. questions above, you will be at least halfway there. Beyond that, there are only a few "rules of thumb."

- Words on paper alone won't get far. If you want potential users to really understand and use your product or innovative practice, you will need to interact with people.
- Work as much as possible through existing channels, networks, and associations. They will carry your messages to the people who are likely users.
- Begin planning for dissemination early in the project; this allows you to prepare the ground. Waiting until the end often means that your public is going to face a steeper learning curve than you did.
- Try to stay with your dissemination long enough to measure its actual impact and assure quality control.

A good rule of thumb is to assign a 3–5% of the project budget to dissemination and allow about 18 months for this phase of the project.

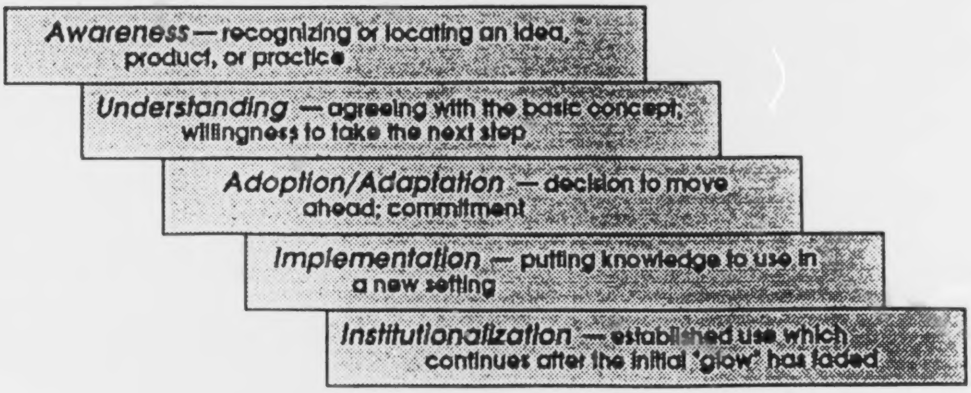
Building the Plan: Decisions

A dissemination plan usually involves five major decisions: (1) defining the purpose; (2) identifying the audience; (3) stating content; (4) designing strategies; and (5) assessing impact. Each step will be discussed in the following sections. It is sometimes necessary to return to earlier steps during the process.

Decision Point #1 — Defining the purpose

One of the first decisions is to determine the desired purposes. A linear continuum helps to review the options in terms of goals to be reached. As one moves along the continuum, increasing effort is required to achieve the goal.

Some NSF dissemination initiatives stop at the level of awareness or understanding. This level might be acceptable for some projects but, if practices or products are to be adopted and implemented, further steps have to be taken. These additional steps require more time and, usually,



Awareness — recognizing or locating an idea, product, or practice

Understanding — agreeing with the basic concept; willingness to take the next step

Adoption/Adaptation — decision to move ahead; commitment

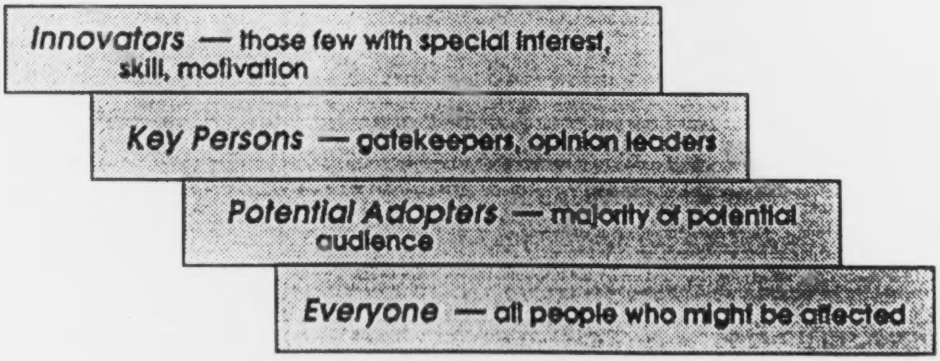
Implementation — putting knowledge to use in a new setting

Institutionalization — established use which continues after the initial "glow" has faded

more funds. The question for Decision Point #1 really involves two considerations: the desired level of dissemination and the available resources.

Decision Point #2 — Identifying the audience

The next decision involves specification of the audience to be reached. Sometimes there may be primary and secondary audiences. Think in terms of specific people and what they already know prior to exposure to this new information. Also consider the number of people who should be reached. The names may not necessarily be stated but can be translated into such descriptors as "department chair," "principal," or "president of the teacher's union."



Innovators — those few with special interest, skill, motivation

Key Persons — gatekeepers, opinion leaders

Potential Adopters — majority of potential audience

Everyone — all people who might be affected

It may be helpful to look at the first two decision points using a matrix that focuses on those elements as shown in Exhibit 1.

To use the matrix, name the persons who will be involved and determine the category into which they

BEST COPY AVAILABLE

Exhibit 1

A Matrix to Assist in Developing a Dissemination Strategy

Level	Audience			
	Innovators (Special Interest)	Key Persons (Gatekeepers)	Potential Adopters	Everyone Who Might Be Affected
Awareness				
Understanding				
Acceptance				
Adoption				
Implementation				
Institutionalization				

fall. Next, indicate the level you want each person to reach. If the Principal Investigator wants the university professor of computer science to be aware, an "x" would be placed in the "special interest" column opposite "awareness." For another purpose, say the "adoption" of the ideas by the "chair of the computer science department," an "x" would be placed at that intersection and a dissemination plan would be developed with that focus in mind.

Decision Point #3 — Stating Content

Content is broadly defined. It may be the research or evaluation findings of a project; a product (such as a computer program, a series of videodisks or a syllabus for a course); a process or procedure combining several of the above. Content is substance. It can be described. It is the essence of what the audience should receive. Once decided, the level of understanding should be determined.

The "stuff" of dissemination is the content. Content is found in products, practices, programs, and policies. "Products" are usually independent, self-standing instructional materials, such as computer software, laboratory kits, videotapes, audiotapes, and textbooks. "Practices" are teaching methods, usually combined with instructional management procedures that are used in teaching/learning environments. They are sometimes called "techniques." Content could also be process—the practice of presenting and interacting with substantive information. It could be "knowledge" created from project findings; it could be a synthesis of separate existing knowledge that yields new understanding when analyzed as a whole.

Content ought to be one of the first considerations of a dissemination plan. What is it that will be disseminated? This is the core of the effort; it is the substance. Without it, there can be no dissemination. The content, combined with purpose and audience provide a basis for systemic change. Exhibit 2 presents an example of purpose, audience, and content combined.

Decision Point #4 — Designing Strategies

"Purpose" (Decision Point #1) and "audience" (Decision Point #2) are considered along with "content" (Decision Point #3) prior to determination of the strategy. Exhibit 2 provides an aid to guide this procedure and the previous example (Exhibit 1) illustrates how these elements are used to develop a strategy.

There are many dissemination strategies that can and should be entertained. Many will be familiar and some are new. The following is an illustrative, but not exhaustive, list:

- Formal report
- Brochure
- Lecture
- Symposium
- Personal Interview
- Demonstration
- Workshop
- Computer Conference
- Electronic Mail
- Video Conference
- Telelecture
- Film
- Laser Disk
- Exhibit

> ***A common failing in the creation of most dissemination plans is to jump to the strategy before considering the prior questions.***

A common failing in the creation of most dissemination plans is to jump to the strategy before considering the prior questions. A Principal Investigator may be taken with the idea of videoconferencing, for example, and select it as a primary approach without thinking through the match between this strategy and the purpose, audience, and content to be addressed. A

Exhibit 2

An Example of Purpose, Audience, and Content Combined

Purpose?	**To develop guidelines and examples for the teaching of laboratory science at a distance.**
Audience?	**Teachers of chemistry who have taught or are interested in teaching at a distance.**
Content?	**The process of designing, developing, and evaluating materials and techniques for teaching chemistry at a distance.**
Strategies?	**An invitational conference; demonstrations; videotapes; electronic networks; reports at professional meetings.**

Distance education is a significant trend in North American secondary and post-secondary education. The availability of courses when schools or colleges cannot be reached because of location, time, or physical handicap has been made possible through a variety of communication technologies: computers, satellite video, telephones, and combinations of media. Most courses can be redesigned for distance learners by utilizing interactive learning techniques. However, the laboratory experiences are an integral part of most beginning courses in chemistry, biology and physics. When students and teachers are remote from each other, it is difficult to provide opportunities for students to experience the discovery that is part of laboratory work.

A proposal to NSF spelled out the need for a national conference to exchange information among secondary and post-secondary teachers of chemistry who were involved in, or contemplated involvement in, teaching chemistry at a distance. This **audience** would bring materials, experiments, and questions to a 3-day conference to exchange information with colleagues. A resource person from the British Open University, where successful chemistry laboratory programs have been offered at a distance, would be available. The **content** centered on materials, techniques, procedures, and student assessment used in teaching chemistry at a distance.

To ensure further dissemination of the conference results, individual participants would give brief demonstrations of their approach and each would be videotaped for later use by individuals who had not attended the conference. Further, during the conference, the organizer would lead the group through a simulation exercise to create a laboratory kit for one topic in chemistry. The process would be documented and later turned into published guidelines for teachers of chemistry (and perhaps other laboratory sciences) to create laboratory kits for distance learners. Availability of the videotape and the guidelines would be announced in journals read by chemistry teachers. A presentation would be given at the national conference. Individuals attending the conference would be included on a national computer network with bulletin board and electronic mail.

BEST COPY AVAILABLE

related problem is the over-reliance on a single strategy. For example, we may assume without really analyzing a situation that a written report is the best way to disseminate findings. This assumption is probably based in large part on the fact that our training has predisposed us to this alternative and we are most comfortable with it. It may not, however, be a strategy for success.

Some examples help to illustrate how various strategies can effectively combine media and procedures to "get the word out" to target audiences.

We begin with the case of a research project that has come up with significant findings. Normally the researcher would seek publication in a refereed journal and a formal presentation at a conference of the field most closely related to the study. If a goal is limited to informing other researchers in the same specialized field about the findings, the normal strategies would apply. However, if the researcher is attempting to stimulate related research by other researchers, a symposium might be arranged, followed by an electronic mail network for day-to-day sharing of information and new findings.

Another example focuses on teaching and learning. A mathematics educator has developed and tested new approaches to teaching geometry using microcomputers. His objective is to gain acceptance of the new approaches by secondary school mathematics teachers from urban schools. Presentations are planned for several national meetings that are usually attended by teachers from the defined audience (understanding). Summer workshops are announced for individuals who have expressed interest in the new procedures (adoption) and a computer network is used for follow-up and interaction among those who have adopted the new techniques and materials (implementation).

Decision Point #5—Assessing Impact

After all the planning, the question is: "Has the dissemination effort made any difference?" Has there been any change in the people who were being addressed? What has happened (if anything) as a result of dissemination?

A first step in measuring "success" is to review the criteria upon which "success" will be determined. Start with the previously stated purpose—to what extent has this purpose been reached? How do you know? If you do not have evidence, how can it be obtained? To what extent are quantitative data helpful and when is qualitative information more useful?

An integral part of any dissemination plan is evaluation of the result.

Too often we are willing to limit ourselves to making information available. An integral part of any dissemination plan is the evaluation of the result. Sometimes such information is not immediately available because it takes time for new users to decide, to adopt, and to gain resources to implement. However, here are some examples of feedback that should be systematically recorded:

- Requests received for more information in writing or by telephone
- Number of individuals (or organizations) that sign-up for training offered by the Principal Investigator
- Number of persons who visit sites where new practices are being used
- Number of invitations for speakers/consultants to come to the site where the new practice is being considered.

Summary

The guidelines presented above provide a general overview of dissemination as it applies to NSF projects. It is intended to assist Principal Investigators in the creation of a dissemination approach. To summarize these suggestions, an overview has been developed to provide tips for dissemination.

7

Making Good Choices among Successful Practices

Audience:

- Individuals responsible for helping educators select among successful programs and practices.

Desired Outcomes for Participants:

- To identify criteria that may be used in program selection.
- To practice applying criteria for analyzing successful programs and practices.

Materials:

- **Transparencies:**
  - *Rules of Brainstorming* (B-1-3)
  - *Spend-A-Buck* (7-7)
  - *Scoring Matrix* (7-8)
  - *Using a Scoring Matrix* (7-9)
- **Handouts:**
  - *Science Education That Supports Emerging National Standards Is . . .* (3-50 and 3-51)
  - *Mathematics That Supports National Standards Is . . .* (4-16 and 4-17)
  - *Screening Promising Practices for Adoption* (7-10 through 7-12)
  - *Scoring Matrix for Selection of Successful Practices in Science and Mathematics* (7-13)
  - *Sample Scoring Matrix for Selection of Successful Practices in Science and Mathematics* (7-14)
  - *Sample Program Descriptions*
    - *Search, Solve, Create, and Share (SSCS)* (7-15 and 7-16)
    - *Foundational Approaches in Science Teaching (FAST)* (7-17 and 7-18)
    - *Project PEAK* (7-19 and 7-20)
    - *Mathematics Education Initiative/MOVE IT Math* (7-21 and 7-22)
    - *The Institute for Science and Mathematics (ISM)* (7-23 and 7-24)
    - *Tools for Scientific Thinking-Force Motion-Force Unit: A Microcomputer-based Laboratory* (7-25 and 7-26)
- Overhead projector, screen, and overhead pens

- Colored adhesive dots (four per participant)
- Newsprint, easel, tape, and markers

Time Required: Three hours

Facilitator's Notes: This activity focuses on the second type of dissemination, choice, described in **Activity 5: What Is Effective Dissemination?** One of the most difficult tasks of a disseminator is to help people think about the array of possible programs available to them and to make informed choices among them. Often educators jump at new programs and practices that are presented with extra enthusiasm or startling research results and don't take the time or effort necessary to do a careful analysis of the program, its requirements, and its fit with their own situation and needs. This activity offers a process for identifying and prioritizing a set of selection criteria and then using those to analyze several programs.

We chose to write this activity as if the participants were a selection committee from a school or district, or, if they do not have that responsibility, as if they were at least from the same district or school. If your group is from a variety of locations, it will not be necessary (nor may it even be possible) for them to come to consensus on a set of selection criteria. We have provided a set of suggested criteria for such groups to use in analyzing descriptions of successful programs.

Note: Process Step 2 uses carousel brainstorming (see **Appendix B-2**), so you will want to prepare and post newsprint with the category headings listed below (Process Step 2), before the activity begins.

Process:

1. Explain that in this activity, participants will experience a process for selecting among a wide variety of successful programs and practices. They will develop some selection criteria and apply them to a sample of programs. Explain that knowing what a district or school wants, values, and thinks is important and will facilitate an informed decision-making process.

   Ask participants to imagine that they are at a national science or mathematics convention. In the exhibit hall, they are faced with hundreds of programs to choose from. Ask participants to turn to a partner and talk for five minutes about the question: When faced with so many options, how do you choose a program you might want to use? What criteria do you use?

Ask a few people to report out their conversations.

2. Explain that the first step in a selection process is to generate and explore criteria as a group.

   Have participants focus on either a science or a mathematics program if there is one of particular interest to the group. If not, have them focus on an integrated science and mathematics program. Tell participants that they will begin by using the process of carousel brainstorming to generate ideas. Refer to **Appendix B-2** and use the **Rules of Brainstorming (B-1-3)** transparency to provide instructions for carousel brainstorming.

   Use the following categories for the carousel brainstorming newsprint (or other categories you decide are more appropriate):

   - What LEARNING GOALS are important?
   - What INSTRUCTIONAL AND ASSESSMENT STRATEGIES AND PHILOSOPHIES do we want?
   - What CONTENT should be included? How should it be organized (topics, themes, skills, interdisciplinary, etc.)?
   - What IMPLEMENTATION REQUIREMENTS (training, time, equipment, cost, etc.) should we look for?
   - What MATERIALS will we want it to include?

   Divide participants into five groups, one group at each newsprint to start. Allow approximately two minutes at the first station to brainstorm ideas about the topic, asking them to write down their responses as they do so.

   After two minutes, have each group move to the next newsprint, read what the group before them wrote, and make additions. Continue the process until groups have responded to each newsprint and come full circle back to their starting place, where they pause for two minutes to read what others have written.

3. When the brainstorming process is complete, distribute handouts from Activities 3 and/or 4 that list characteristics of effective science and mathematics programs, according to national standards (**Science Education That Supports Emerging National Standards Is . . . , 3-50 and 3-51**, and **Mathematics Education That Supports National Standards Is . . . , 4-16 and 4-17**). Briefly review the

handouts. Ask participants to make checks or jot notes about what they might want to add to the newsprint. (They'll have the opportunity in a couple of minutes.)

Distribute the handout **Screening Promising Practices for Adoption (7-10 through 7-12)**. Note that this is a form that has been used for selection of successful programs. Point out the criteria used on this form and ask them to make checks or jot notes about other items they might want to consider adding to the newsprint.

Post another piece of newsprint with "Other Criteria" on the top. Explain that they will now have a chance to make additions or changes to the newsprint. Ask them to assemble with the same groups at the newsprint where they began their carousel brainstorming. For the next ten minutes, they do not have to stay in their groups. They will do a "gallery tour," circulating, reading, adding if they wish, and commenting on each station. Encourage them to write on the "Other" newsprint as well.

4. Back at their seats, ask participants to discuss these questions with their partners:

   - What do you notice about the information on the newsprint (trends, discrepancies, agree or not)?

   - Why is it important to be explicit about criteria that will be used in a selection process and get ideas down in writing?

   Ask for a few ideas to be reported out.

5. Explain that sometimes this data-generating process produces divergent ideas about what an optimal program or practice should be. Introduce a consensus-building process by showing the **Spend-A-Buck (7-7)** transparency.

   Distribute four colored adhesive dots to each participant. Explain that they each have four quarters (represented by the dots) that they will use to "vote" for the criteria on the pieces of newsprint that they feel are most critical. Ask them to walk around the newsprint once again and place their dots on their priorities.

   Note: This process only works well when your group is from the same school or district, and especially if they are a selection committee. If your group is from a variety of locations, you may want to tell them about this process, but not actually do it. Then, skip to Step 7.

Explain that the carousel brainstorming and prioritizing procedures help selection committees to be clear about what they value. If contradictory dialogues emerge during the selection process, they can go back to the data on the newsprint to help settle disputes.

6. Show the **Scoring Matrix (7-8)** transparency and distribute the handout **Scoring Matrix for Selection of Successful Practices in Science and Mathematics (7-13)**. Explain that this format will help the analysis process when they are looking at a number of successful practices. The first step is to fill in the set of selection criteria across the horizontal axis that they prioritized highest on the newsprint. As a large group, look at the newsprint and identify the six largest "vote-getters" and fill in the names on the matrix under Selection Criteria (you write on the transparency, they write on the handouts). Note that they would ordinarily have a much longer discussion about which ones to put in, whether they need to have more, etc., but for the sake of practice you will limit the discussion to the six most often chosen. They will now use this matrix to analyze a set of successful program descriptions. Skip to Step 8.

7. If your group did not develop its own matrix, distribute the handout **Sample Scoring Matrix for Selection of Successful Practices in Science and Mathematics (7-14)** and explain how the selection criteria could be narrowed from the brainstormed lists they created.

8. Show the **Using a Scoring Matrix (7-9)** transparency and point out that this is an example of how a selection committee used a set of selection criteria they generated to score five science and mathematics programs. They used a scale of 1 to 5, and the total scores indicate which programs met more of their criteria. Note that it is possible to weight criteria; for example, those that are most important might have a maximum score of 5 and those that are less important, a maximum score of 3.

9. Ask participants to pair up. Distribute two of the **Sample Program Descriptions (7-15 through 7-26)** to each pair. Explain that this pool of programs come from curriculum development efforts around the country, successful practices identified by the regional educational laboratories, and programs funded for dissemination through the National Diffusion Network. These descriptions are quite short but are included here for ease of use.

   Ask participants to use their own scoring matrix to analyze the two program descriptions. Have them keep track of issues or questions about the process to share later. Allow 20 minutes.

10. After groups have completed their analysis, ask them to share their issues and questions for general discussion. Have participants share other methods they have tried for making choices among successful practices. Explain that using brief written descriptions is insufficient for making final choices and that they would need to decide next steps, such as making a site visit, viewing videos, inviting the developer or representative teacher(s) to come and talk with them, etc.

11. Ask participants where they think successful programs or practices fit in systemic reform. Have them consult their definition of systemic change, originally developed in **Activity 1: Framing the Dialogue Around Systemic Change.** Some possible places are:

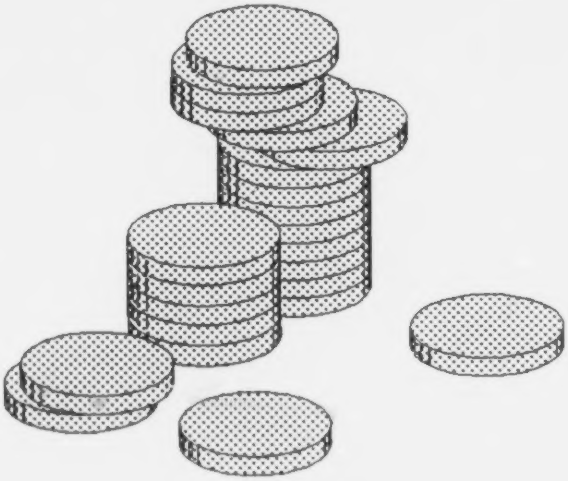
    - Once people have a shared vision, they can imagine what needs to happen in the classroom to promote the vision; some of their descriptions of teacher and student activity could be used as criteria for selecting new programs or practices to try.

    - Professional development and curriculum development need to be integrated for systemic change; a new program with an effective professional development component would do this.

    Ask whether their analysis of the programs suggests changes in their definitions.

12. Ask participants to reflect on, talk about, and/or write: What have I learned in this activity? How can I use what I have learned?

SPEND-A-BUCK



- Each person has four quarters to spend.

- The quarters must be spent on at least two items.

SCORING MATRIX

	SELECTION CRITERIA						
PROGRAM TITLE							TOTAL SCORE

USING A SCORING MATRIX

	SELECTION CRITERIA						
PROGRAM TITLE	Evidence that the program works with a diverse student population	Fits in with a constructivist philosophy of learning	Activities accommodate a variety of learning styles	Assessment imbedded in activities	Training available from program developer	No computers required to implement	TOTAL SCORE
Less Ought to Be Enough (LOBE)	5	4	3	3	2	5	22
Problems Without Solutions (PWS)	4	3	2	4	3	3	19
Connecting the Chasm (CC)	3	4	5	4	2	2	20
Confounding With Technology (CWT)	4	5	3	3	3	1	19
Everybody Counts Sometime (ECS)	5	3	4	5	4	4	25

SCREENING PROMISING PRACTICES FOR ADOPTION

YOU ARE THE BUYER. You are the potential selector, adopter, or user of promising practices for classroom use by students, for professional development by teachers, or for changes in service delivery systems. THE SELLER is the developer and/or purveyor of a promising practice. The seller is responsible for presenting wares in terms that will make it possible for you to decide whether they will be useful, practical, and successful for YOU. AS THE BUYER, you are responsible for: (a) knowing what you need programmatically; (b) knowing yourself – your local conditions, contexts, and resources; and (c) asking structural questions whose answers will tell you whether a promising practice fits.

WHEN YOU USE THIS SCREENING SHEET, you are shopping to fill an identified programmatic need. (For example, you know the curriculum area and target population to be served by the practice you are seeking.) The Screening Sheet lists structural and contextual questions that you should ask about a promising practice and about yourself, and it suggests a scale for rating the relative match between the practice and yourself.

SCREENING SHEET

CLAIMS	What goals and objectives is the practice designed to achieve?	What goals and objectives am I seeking to fulfill?	1 2 3 4 5 No Match Good Match

Notes: ______________________________

____

____

EFFECTIVENESS	What evidence proves that the practice is successful in achieving what it claims?	How stringently should effectiveness be demonstrated by practices in this domain? IS THE EVIDENCE CONVINCING?	1 2 3 4 5 No Evidence Convincing Evidence

Notes: ______________________________

____

____

Source: Reprinted with permission of Counterpoint Communications from *Counterpoint* by Judy Smith-Davis, n.d.

SCREENING PROMISING PRACTICES FOR ADOPTION (continued)

HISTORY OF USE	In what administrative, geographical, and educational settings has the practice been used?	What are the definitive qualities of my administrative, geographical, and educational setting?	1 2 3 4 5 Non-Matching History … Matching History
	Notes: ____________________ ____________________ ____________________		
MINIMUM STANDARDS FOR REPLICATIONS	Exactly what must the adopter do to achieve success? Is the practice completely prescribed, or does it permit adjustments and additions by the adopter? Does anything have to be added at the adopter site?	What am I willing and able to do to replicate a practice? Am I seeking a flexible or prescribed program to meet this need? What am I willing and able to add to the practice I adopt?	1 2 3 4 5 No Standards … Acceptable Standards
	Notes: ____________________ ____________________ ____________________		
COMPATIBILITY	How much change will this practice create in parallel systems and programs? What background or level of sophistication does the practice demand of users or participants?	How much overall change do I seek? How far does this practice depart from my established policy and practice? What is the background and level of sophistication of my intended users and participants?	1 2 3 4 5 Incompatible … Compatible
	Notes: ____________________ ____________________ ____________________		

SCREENING PROMISING PRACTICES FOR ADOPTION (continued)

ASSISTANCE WITH IMPLEMENTATION	How is this practice conveyed to new users? What follow-up and problem-solving assistance is given?	What kinds of training or assistance will I need to implement a new practice? Will I need external follow-up and problem-solving from the developer?	1 2 3 4 5 Inadequate Assistance — Adequate Assistance

Notes: ____________________

____

____

COSTS	What is the purchase price of adoption and training? What is the cost of implementing and maintaining the practice? What additional resources does the practice require in money, personnel, facilities, equipment, and materials? What learning materials or other material are required? Where do they come from? How much do they cost? Are they reusable or reproducible?	What budget has been estimated for initiating a new practice? What budget has been estimated for implementing and maintaining a new practice? What additional resources are available for initiating and implementing a new practice? What budget has been estimated for purchasing, supplementing, and reproducing materials?	1 2 3 4 5 Low Cost — High Cost

Notes: ____________________

____

____

PAYOFF	How rapidly does the practice achieve its goals? How many individuals can participate simultaneously? Does the package include evaluation procedures for measuring success?	What is my timeline for producing change? What is the total number of individuals intended to participate in this practice? What are my criteria for judging the success of my replication of this practice?	1 2 3 4 5 Low Payoff — High Payoff

Notes: ____________________

____

____

SCORING MATRIX FOR SELECTION OF SUCCESSFUL PRACTICES IN SCIENCE AND MATHEMATICS

	SELECTION CRITERIA						
PROGRAM TITLE							TOTAL SCORE

Using a scale of 1 (least desirable) to 5 (most desirable), rank each program on the basis of the criteria selected. After all items for all programs have been scored, add the columns horizontally and place the total under the Total Score column at the right side of the grid. Programs with the highest totals are those that should most closely match your instructional needs.

Each school or district using this matrix will have its own priorities and may wish to weigh some criteria more heavily than others. Adjustments to the total points awarded for a category may be made to take those priorities into consideration (e.g., using a scale of 1 to 3 for less important criteria).

SAMPLE SCORING MATRIX FOR SELECTION OF SUCCESSFUL PRACTICES IN SCIENCE AND MATHEMATICS

	SELECTION CRITERIA						
PROGRAM TITLE	Evidence that the program works with a diverse student population	Fits in with a constructivist philosophy of learning	Activities accommodate a variety of learning styles	Assessment imbedded in activities	Training available from program developer	No computers required to implement	**TOTAL SCORE**
Less Ought to Be Enough (LOBE)	5	4	3	3	2	5	22
Problems Without Solutions (PWS)	4	3	2	4	3	3	19
Connecting to Chasm (CC)	3	4	5	4	2	2	20
Confounding With Technology (CWT)	4	5	3	3	3	1	19
Everybody Counts Sometime (ECS)	5	3	4	5	4	4	25

Using a scale of 1 (least desirable) to 5 (most desirable), rank each program on the basis of the criteria selected. After all items for all programs have been scored, add the columns horizontally and place the total under the Total Score column at the right side of the grid. Programs with the highest totals are those that should most closely match your instructional needs.

Each school or district using this matrix will have its own priorities and may wish to weigh some criteria more heavily than others. Adjustments to the total points awarded for a category may be made to take those priorities into consideration (e.g., using a scale of 1 to 3 for less important criteria).

SEARCH, SOLVE, CREATE, AND SHARE (SSCS)

The University of Iowa
Iowa City, IA

An Interdisciplinary Approach to Problem Solving In Math and Science

TOPIC: Multidisciplinary Studies, Elementary Math, General Math, Elementary Science, Environmental Studies Biology/Life Science, Physics, Earth/Space Science, Chemistry

USER(S): K-12 Educators, Curriculum Specialists, School Administrators, College Faculty

TARGET POPULATION: All Students

EMPHASIS ON:

Instructional Materials

- Program Packet
- Supplemental
- Learning/Teaching Materials
- Inservice Handbooks

Teaching Strategies

- Hands-On Learning
- Student-Centered Learning
- Thematic Teaching Approach
- Whole Language Approach
- Cooperative/Group Learning
- Individualized/Self-Paced Learning
- Technology-Based Strategies

Assessment Tools

- Student Assessment Materials
- Attitude Surveys/Inventories
- Teacher Reaction Inventories
- Portfolios
- Interaction Analysis - Coding Videotapes

GENERAL DESCRIPTION

Search, Solve, Create and Share is a problem-solving instructional model which provides students with concrete experiences for learning meaningful science. The student is encouraged to conduct a search of what is known and to extend that knowledge base through application or problem solving.

Innovative Features: A problem-solving instructional strategy focusing on student-centered learning, with emphasis placed on application of knowledge, is coupled with a "top-down - bottom up" inservice component that integrates higher education research perspective, K-12 administrators' leadership skills, and K-12 practitioners' knowledge of teaching-learning processes. Central to inservice is the concept of peer tutoring among teachers.

Goals: The primary goal is to provide an environment which encourages students to learn problem solving and science concepts through concrete experiences. In addition, the students expand and apply existing knowledge and critical thinking skills while generating new knowledge using a constructivist approach.

Effectiveness: Significant gains have been made in student achievement and attitude toward science, and 40% sustained use of SSCS teaching by teachers following inservice.

Staff Support: The program is implemented by K-12 educators who will need staff development directed by higher education faculty and ongoing networking with other K-12 teachers.

Source: ***Promising Practices in Mathematics and Science Education*** **by the Laboratory Network Program. Philadelphia, PA: Research for Better Schools. 1993, 88-89.**

SEARCH, SOLVE, CREATE, AND SHARE (SSCS) (continued)

NCISE Standards met:

- ☑ Accessible to all students.
- ☑ Build on students' prior experience and knowledge.
- ☑ Use an instructional model based on the scientific process such as: question, discover, create, communicate, and pursue new questions.
- ☑ Relate to personal and social needs.
- ☑ Select science concepts that are developmentally appropriate, with illustrative examples drawn from the content of multiple disciplines of science.
- ☑ Develop scientific thinking skills such as drawing conclusions based on evidence, using inference, creating models.
- ☑ Develop scientific habits of mind such as curiosity, skepticism, honesty, living with ambiguity.
- ☑ Use authentic assessments to chart teaching and learning.
- ☑ Shift the role of teacher from imparter of knowledge to designer and facilitator of learning.
- ☑ Seek relevant and significant applications of science content and concepts to students' personal and community life.

NCTM standards met:

- ☑ Pose tasks based on sound and significant mathematics.
- ☑ Build on students' prior experience and knowledge.
- ☑ Develop mathematics thinking skills that convince students of the validity of particular representations, solutions, conjectures, and answers.
- ☑ Engage students' intellect; pose questions and tasks that elicit, engage, and challenge each students' thinking.
- ☑ Develop students' mathematical knowledge and skills.
- ☑ Stimulate students to make connections and develop a coherent framework for mathematical ideas.
- ☑ Call for problem formulation, problem solving, and mathematical reasoning.
- ☑ Promote the development of all students' dispositions to do mathematics.
- ☐ Develop an instructional model based on the range of ways students learn mathematics.

RESOURCES/MATERIALS NEEDED FOR ADOPTION:

SSCS does not require extensive materials and/or curriculum resources. No special materials are required for students. Teachers receive the SSCS Implementation Handbook to use as a resource when they are trained.

Equipment Needed:

- N/A

Support Needed:

- Staff Development
- Training Packets
- Videotapes
- Workshop/Inservice
- Consultants/Trainers
- Teacher Collaboration/Support Groups

FUNDED BY: Chapter II, National Science Foundation, Eisenhower Mathematics and Science Education Program, District, State, The University of Iowa

CONTACT:
Barbara Sandall
North Central Regional Educational Laboratory
1900 Spring Rd., Suite 300
Oak Brook, IL 60521
(708) 571-4700

SITE(S):
Iowa City Community School District
Muscatine Community School District
Ft. Dodge Community School District

(*Note:* Visitations can be arranged at these and other sites through the contact listed.)

Source: North Central Regional Educational Laboratory

FOUNDATIONAL APPROACHES IN SCIENCE TEACHING (FAST)

University of Hawaii
Honolulu, HI

FAST: A Hands-On Interdisciplinary, Environmental Science Program

TOPIC: Biology/Life Science, Physics, Earth/Space Science, Chemistry, Environmental Studies

USER(S): 6-10 Educators

TARGET POPULATION: All Students

EMPHASIS ON:

Instructional Materials

- Self-Contained Program/Packet
- Supplemental Learning/Teaching Materials
- Technology-Based Materials

Teaching Strategies

- Hands-On Learning
- Student-Centered Learning
- Thematic Teaching Approach
- Cooperative/Group Learning
- Technology-Based Strategies

Assessment Tools

- Student Assessment Materials
- Teacher Reaction Inventories
- Program Review Materials
- Technology-Based Tools

GENERAL DESCRIPTION

The **FAST** program is an interdisciplinary, environmental science program which emphasizes basic concepts and methods of the physical, biological, and earth sciences and relates these to the practical issues of human use of the environment. FAST is designed for students in grades 6-10.

Innovative Features: The FAST program is a true constructivist curriculum where students make their own knowledge out of their own research. It involves students about 70% to 80% of their time in active investigation, linking their findings to the practical societal world. FAST provides opportunities for mathematically adept students to reinforce and expand their skills while helping mathematically struggling students to perform quantitative analysis through graphic means.

FAST assumes that every child builds a unique understanding of the world, which is normalized through teaching; that in science and technology a successful path to normalization is found in reliving the generation of seminal ideas, techniques, and inventions; and that the content and inquiry reflect the nature of the disciplines and technologies being studied.

Effectiveness: In the the fall of 1992 FAST was being used by some 450,000 students in Hawaii, the mainland US, the Pacific islands, and 7 foreign countries. FAST has been in the National Diffusion Network since 1982.

Staff Support: A two-week teacher institute is required.

Source: *Promising Practices in Mathematics and Science Education* by the Laboratory Network Program. Philadelphia, PA: Research for Better Schools. 1993, 62-63.

FOUNDATIONAL APPROACHES IN SCIENCE TEACHING (FAST) (continued)

NCISE Standards met:

- ☑ Accessible to all students.
- ☑ Build on students' prior experience and knowledge.
- ☑ Use an instructional model based on the scientific process such as: question, discover, create, communicate, and pursue new questions.
- ☑ Relate to personal and social needs.
- ☑ Select science concepts that are developmentally appropriate, with illustrative examples drawn from the content of multiple disciplines of science.
- ☑ Develop scientific thinking skills such as drawing conclusions based on evidence, using inference, creating models.
- ☑ Develop scientific habits of mind such as curiosity, skepticism, honesty, living with ambiguity.
- ☑ Use authentic assessments to chart teaching and learning.
- ☑ Shift the role of teacher from imparter of knowledge to designer and facilitator of learning.
- ☑ Seek relevant and significant applications of science content and concepts to students' personal and community life.

NCTM standards met:

- ☐ Pose tasks based on sound and significant mathematics.
- ☐ Build on students' prior experience and knowledge.
- ☐ Develop mathematics thinking skills that convince students of the validity of particular representations, solutions, conjectures, and answers.
- ☐ Engage students' intellect; pose questions and tasks that elicit, engage, and challenge each students' thinking.
- ☐ Develop students' mathematical knowledge and skills.
- ☐ Stimulate students to make connections and develop a coherent framework for mathematical ideas.
- ☐ Call for problem formulation, problem solving, and mathematical reasoning.
- ☐ Promote the development of all students' dispositions to do mathematics.
- ☐ Develop an instructional model based on the range of ways students learn mathematics.

RESOURCES/MATERIALS NEEDED FOR ADOPTION:

Student Book
Reference Booklet Library
Evaluation Guide
Instructional Guide
Equipment Building Kit

Equipment Needed:

- Standard Middle School Laboratory Equipment

Support Needed:

- Staff Development
- Training Packets
- Workshop/Inservice
- Consultants/Trainers

Note: The FAST project requires that for each of the three levels of the program that all teachers attend a 60-hour workshop. Institutes are taught by an instructional staff of expert FAST teachers who have themselves undergone further instruction to become staff members. The institute is supported by a special instructor's guide.

FUNDED BY: University of Hawaii

CONTACT:

Donald B. Young, Associate Professor
1776 University Avenue, CM117
Honolulu, HI 96822
(808) 956-7863
Fax: (808) 956-9486

SITE(S):

43 Demonstration Sites Nationwide Including:
University Laboratory School
University of Hawaii
1776 University Ave.
Honolulu, HI 96822
(808) 956-7833

PROJECT PEAK

Mobile, AL

Magnet Schools for Math and Science

TOPIC: Multidisciplinary, General Math, Pre-Algebra, Environmental Studies, Biology/Life Science, Earth/Space Science, Physical Sciences

USER(S): K-8 Educators

TARGET POPULATION: Ethnic/Minority Students

EMPHASIS ON:

Instructional Materials	**Teaching Strategies**	**Assessment Tools**
• N/A	• Hands-On Learning	• N/A
	• Student-Centered Learning	
	• Whole-Language Approach	
	• Cooperative/Group Learning	
	• Technology-Based Strategies	

GENERAL DESCRIPTION

The Chickasaw and Clark Schools of Mathematics and Science established one elementary magnet and one middle magnet school during the 1991-1992 school year. The purposes of the program are to eliminate, reduce, or prevent the isolation of minority students and to provide students with courses of instruction that will reflect new math and science standards.

Innovative Features: This program uses computer-assisted instruction and mathematics and science manipulative labs. In addition, teachers enhance instruction by utilizing Talents Unlimited, Cooperative Learning, PEAK and other mini courses.

Goals: The goals of the program are to document the improvement of the student's self esteem, competency level in labs, and classroom and computer academic performance; to increase the student's interest in math and science related fields; and to provide an integrated atmosphere of acceptance and mutual respect for one another.

Effectiveness: The program is monitored and assessed by the individual school's staff, Mobile County Public School System supervisors, parent/community committees, the project facilitator, and the use of valid assessment instruments.

Staff Support: Extensive teacher training and staff development are an integral part of this program.

Source: *Promising Practices in Mathematics and Science Education* by the Laboratory Network Program. Philadelphia, PA: Research for Better Schools. 1993, 82-83.

PROJECT PEAK (continued)

NCISE Standards met:

☑ Accessible to all students.

☑ Build on students' prior experience and knowledge.

☑ Use an instructional model based on the scientific process such as: question, discover, create, communicate, and pursue new questions.

☑ Relate to personal and social needs.

☑ Select science concepts that are developmentally appropriate, with illustrative examples drawn from the content of multiple disciplines of science.

☑ Develop scientific thinking skills such as drawing conclusions based on evidence, using inference, creating models.

☑ Develop scientific habits of mind such as curiosity, skepticism, honesty, living with ambiguity.

☑ Use authentic assessments to chart teaching and learning.

☑ Shift the role of teacher from imparter of knowledge to designer and facilitator of learning.

☑ Seek relevant and significant applications of science content and concepts to students' personal and community life.

NCTM standards met:

☑ Pose tasks based on sound and significant mathematics.

☑ Build on students' prior experience and knowledge.

☑ Develop mathematics thinking skills that convince students of the validity of particular representations, solutions, conjectures, and answers.

☑ Engage students' intellect; pose questions and tasks that elicit, engage, and challenge each students' thinking.

☑ Develop students' mathematical knowledge and skills.

☑ Stimulate students to make connections and develop a coherent framework for mathematical ideas.

☑ Call for problem formulation, problem solving, and mathematical reasoning.

☑ Promote the development of all students' dispositions to do mathematics.

☑ Develop an instructional model based on the range of ways students learn mathematics.

RESOURCES/MATERIALS NEEDED FOR ADOPTION:

Video disc programs, computer hardware and software, and lab manipulatives that support the math/science theme are important program tools.

Equipment Needed:

- VCR and Monitor
- Manipulatives
- IBM or Macintosh Computer
- Software
- Videodisc Player
- Hands-On Equipment

Support Needed:

- Orientation
- Staff Development
- Technical Assistance
- Training Packets
- Workshop/Inservice
- Consultants/Trainers
- Teacher Collaboration/Support Groups
- Computers and Software

FUNDED BY: Federal Grant

CONTACT:

SERVE Consortium for Mathematics
and Science Education
345 S. Magnolia Dr., Suite D-23
Tallahassee, FL 32301-2950
(904) 922-8533; (800) 854-0476
Fax: (904) 922-8068

SITE(S):

Chickasaw School of Mathematics & Science
201 N. Craft Hwy.
Chickasaw, AL 36611

Clark School of Mathematics & Science
1712 Hand Ave.
Mobile, AL 36612

Source: SouthEastern Regional Vision for Education

MATHEMATICS EDUCATION INITIATIVE/MOVE IT MATH

University of Houston-Victoria
Victoria, TX

K-6 Hands-on, Discovery Mathematics for ALL Children

TOPIC: Elementary Math

USER(S): K-6 Educators, Curriculum Specialists, School Administrators, College Faculty, Education Consultants, Parents

TARGET POPULATION: All Students

EMPHASIS ON:

Instructional Materials

- Supplemental Learning/Teaching Materials
- Teaching Lessons/Units
- Curriculum Guides
- Technology-Based Materials

Teaching Strategies

- Hands-On Learning
- Student-Centered Learning
- Cooperative/Group Learning
- Technology-Based Strategies

Assessment Tools

- N/A

GENERAL DESCRIPTION

MOVE IT Math is a K-6 university-supported professional development program. It advocates mathematics instruction based on the use of manipulatives. It consists of three 30-hour inservices: Everyone Can Learn Math, Enrichment & Accelerate, and Advanced Topics.

Innovative features: MOVE IT Math includes the following:

1. Immersion in manipulatives until the mathematics being modeled is internalized;
2. introduction to algebra as early as kindergarten;
4. use of children's literature and science to give meaning and purpose to mathematics;
5. attention to mathematics as a language for explaining certain events;
6. emphasis on understanding rather than memorization;
7. students discovery of the "rules" of mathematics through pattern examination;
8. flexibility in its exposition and acceptance of alternative ways to solve problems; and
9. teaching "essential elements," not covering textbook pages.

Goals: MOVE IT Math seeks a balance between skills, concepts, and problem solving in order to: 1. elevate scores on standardized exams; 2. meet the challenge of changing demographics; 3. improve student attitudes toward mathematics and teacher attitudes toward teaching mathematics; 4. mainstream "at risk" students for mathematics; 5. aid "at-risk" students in meeting grade-level expectations; and 6. prepare students to participate in a mathematically literate global economy. An objective of the program is that all children will be ready for a quality algebra class in the 8th grade.

Effectiveness: Data collected in 1989 indicated that approximately 80% of the children classified as at-risk (i.e., one year below grade level in reading and/or mathematics) were no longer classified as such after being in the program for approximately six months. All children in an elementary school tested out of the "Chapter" program for mathematics in 1992-93 after implementing the program. Also, teachers report increased understanding, enthusiasm, and interest in teaching mathematics. In some schools, student attendance and discipline problems have shown marked improvement.

Source: *Promising Practices in Mathematics and Science Education* by the Laboratory Network Program. Philadelphia, PA: Research for Better Schools. 1993, 14-15.

MATHEMATICS EDUCATION INITIATIVE/MOVE IT MATH (continued)

NCISE Standards met:

- ☐ Accessible to all students.
- ☐ Build on students' prior experience and knowledge.
- ☐ Use an instructional model based on the scientific process such as: question, discover, create, communicate, and pursue new questions.
- ☐ Relate to personal and social needs.
- ☐ Select science concepts that are developmentally appropriate, with illustrative examples drawn from the content of multiple disciplines of science.
- ☐ Develop scientific thinking skills such as drawing conclusions based on evidence, using inference, creating models.
- ☐ Develop scientific habits of mind such as curiosity, skepticism, honesty, living with ambiguity.
- ☐ Use authentic assessments to chart teaching and learning.
- ☐ Shift the role of teacher from imparter of knowledge to designer and facilitator of learning.
- ☐ Seek to find relevant and significant applications of science content and concepts to students' personal and community life.

NCTM standards met:

- ☑ Pose tasks based on sound and significant mathematics.
- ☑ Build on students' prior experience and knowledge.
- ☑ Develop mathematics thinking skills that convince students of the validity of particular representations, solutions, conjectures, and answers.
- ☑ Engage students' intellect; pose questions and tasks that elicit, engage, and challenge each students' thinking.
- ☑ Develop students' mathematical knowledge and skills.
- ☑ Stimulate students to make connections and develop a coherent framework for mathematical ideas.
- ☑ Call for problem formulation, problem solving, and mathematical reasoning.
- ☑ Promote the development of all students' dispositions to do mathematics.
- ☑ Develop an instructional model based on the range of ways students learn mathematics.

RESOURCES/MATERIALS NEEDED FOR ADOPTION:

1. Manipulatives – in particular mathematics balance – multibase blocks and/or counters for trading activities, fraction circles (to support Level 1 inservice).
2. Library of teacher resource materials covering the seven strands from the NCTM Mathematics Standards (to support Level 2 and 3 inservices), estimated cost of $5000, which the district must agree to purchase.
3. Access to a computer in order to access the data base for selecting lessons from the library and to personalize the curriculum to address local student needs.

Equipment Needed:

- Manipulatives
- Computer Equipment
- Special Hands-On Equipment (exchange blocks, fraction cakes)

Support Needed:

- Orientation
- Staff Development
- Training Packet
- Workshop/Inservice
- Consultants/Trainers
- Teacher Collaboration/Support Groups
- Administrative Support

Note: Participants begin with an overview on the need for mathematics reform in the early grades. Workshops are conducted by two trainers who must have used MOVE IT Math in their classrooms for a minimum of one year. Workshops are limited to 35 participants and are supported with a 350-page instructional packet for teachers and an implementation guide for administrators. Teachers receive scope and sequence support materials and the district sponsoring the inservice receives a curriculum database keyed to the essential elements. Four teacher resource books and supporting videos are being produced for Level 1 MOVE IT Math. These materials and additional teacher resource books and videos will be produced for Levels 2 and 3.

FUNDED BY: Eisenhower Mathematics and Science Education Program. Typically, funds provide manipulatives and resource materials used to implement the program with a school or school district paying tuition for three hours of university graduate credit and the University of Houston-Victoria paying for instruction.

CONTACT:

Dr. Paul Shoecraft, Director MEI
Lynne Shoecraft, Assistant Director MEI
University of Houston-Victoria
2506 E. Red River
Victoria, TX 77901
(512) 576-3151; Fax: (512) 572-8463

SITE(S):

Comal Independent School District
1421 Highway 81 East
New Braunfels, TX 78130

Source: Southwest Educational Development Laboratory

THE INSTITUTE FOR SCIENCE AND MATHEMATICS (ISM)

Grant High School
Portland, OR

Increasing Student Awareness of Science & Mathematics Through Experiential Learning

TOPIC: General Math, Pre-Algebra, Algebra I, Geometry, Algebra II, Trigonometry, Calculus, Technology Studies, Environmental Studies, Biology/Life Science, Physics, Earth/Space Science, Chemistry

USER(S): 9-12 Educators, Curriculum Specialists, School Administrators, Technology Specialists, Parents, Researchers, Paraprofessionals

TARGET POPULATION: Urban, At-Risk, Ethnic/Minority, Honors/Advanced Placement, Learning Disabilities, Female

EMPHASIS ON:

Instructional Materials

- Supplemental Learning/Teaching Materials
- Thematic Instructional Package
- Teaching Package with Lessons/Units
- Curriculum Guides
- Technology-Based Materials

Teaching Strategies

- Hands-On Learning
- Student-Centered Learning
- Thematic Teaching Approach
- Cooperative/Group Learning
- Technology-Based Strategies

Assessment Tools

- Student Assessment Materials
- Attitude Surveys/Inventories
- Program Review Materials
- Needs Assessment Surveys
- Portfolios
- Technology-Based Tools

GENERAL DESCRIPTION

The **ISM** challenges students through a continuous-study core curriculum. ISM students enroll in an introductory common course which also functions as an advisory class in the transition to high school.

Innovative Features: The ISM successfully combines several emerging curriculum projects and research-based practices into a specialized high school experience accessible to all students. The ISM expands the content of secondary mathematics and science to include areas such as statistical data analysis, probability, discrete mathematics, spatial reasoning, real world science, and ethics. It uses technology, graphing calculators and computers and includes self-assessment, student portfolios, teacher observations, and group work.

Goals: The goals of the ISM are to excite student interest in mathematics and science; to increase minority and female student enrollment in mathematics and science courses; and to develop students' potential to meet the changing demands of higher education, business, and industry.

Effectiveness: Enrollment in mathematics and science classes has increased between eight and twelve percent and is more representative of the neighborhood ratio of students by gender, ethnicity, and achievement levels. Last year, failure rate for Interactive Mathematics was three percent compared to 25% in regular first-year Algebra classes. Student portfolios document extensive participation in co-curricular math and science activities. Staff, students, and parents report increased student confidence and broader knowledge of mathematics and science.

Staff Support: The program is implemented by high school educators with the support of curriculum specialists, school administrators, technology specialists, parents, and paraprofessionals.

Source: ***Promising Practices in Mathematics and Science Education*** **by the Laboratory Network Program. Philadelphia, PA: Research for Better Schools. 1993, 70-71.**

THE INSTITUTE FOR SCIENCE AND MATHEMATICS (ISM) (continued)

NCISE Standards met:

☑ Accessible to all students.

☑ Build on students' prior experience and knowledge.

☑ Use an instructional model based on the scientific process such as: question, discover, create, communicate, and pursue new questions.

☑ Relate to personal and social needs.

☑ Select science concepts that are developmentally appropriate, with illustrative examples drawn from the content of multiple disciplines of science.

☑ Develop scientific thinking skills such as drawing conclusions based on evidence, using inference, creating models.

☑ Develop scientific habits of mind such as curiosity, skepticism, honesty, living with ambiguity.

☑ Use authentic assessments to chart teaching and learning.

☑ Shift the role of teacher from imparter of knowledge to designer and facilitator of learning.

☑ Seek relevant and significant applications of science content and concepts to students' personal and community life.

NCTM standards met:

☑ Pose tasks based on sound and significant mathematics.

☑ Build on students' prior experience and knowledge.

☑ Develop mathematics thinking skills that convince students of the validity of particular representations, solutions, conjectures, and answers.

☑ Engage students' intellect; pose questions and tasks that elicit, engage, and challenge each students' thinking.

☑ Develop students' mathematical knowledge and skills.

☑ Stimulate students to make connections and develop a coherent framework for mathematical ideas.

☑ Call for problem formulation, problem solving, and mathematical reasoning.

☑ Promote the development of all students' dispositions to do mathematics.

☑ Develop an instructional model based on the range of ways students learn mathematics.

RESOURCES/MATERIALS NEEDED FOR ADOPTION:

The ISM classes use a combination of adapted classroom-tested materials and teacher-developed lessons. The Interactive Mathematics Project curriculum units are the basis of the three-year Interactive Mathematics course which replaces the traditional courses. Salters' Science, developed at the University of York, England, is similarly replacing more conventional text-based science study throughout the department. These materials require few additional resources although manipulative math materials and class sets of graphing calculators are needed.

Equipment Needed:

- Manipulatives
- Graphing calculators

Support Needed:

- Implementation of significant changes in both content and instructional methods requires an array of support, including orientation, staff development, technical assistance, workshop/inservice, consultants/trainers, teacher collaborations, and support groups.
- Most effective are monthly collaborative planning meetings and approximately thirty hours of inservice activities yearly for mathematics and science teachers. In addition the "ISM Roundtable" combines collegial support with action-research projects.

FUNDED BY: State Eisenhower grant, District. National Science Foundation funded the work of the Interactive Mathematics Project in California. No National Science Foundation funds directly support the ISM.

CONTACT:
Fred Rectanus, Program Coordinator
Grant High School
2245 N. E. 36th Avenue
Portland, OR 97212
(Mail Inquiries Only)

SITE(S):
Grant High School
2245 N. E. 36th Avenue
Portland, OR 97212

Source: Northwest Regional Educational Laboratory

TOOLS FOR SCIENTIFIC THINKING–FORCE MOTION–FORCE UNIT: A MICROCOMPUTER–BASED LABORATORY

Center for Science and Mathematics Teaching, Tufts University
Medford, MA

High School Program Using Microcomputers to Help Students Attain Newtonian View of Motion & Force

TOPIC: Physics

USER(S): 9-12 Educators, Curriculum Specialists, School Administrators, Program Planners, College Faculty, Education Consultant

TARGET POPULATION: All Students

EMPHASIS ON:

Instructional Materials	Teaching Strategies	Assessment Tools
• A Self-Contained Program/Packet • Thematic Instructional Pkg. • Teaching Lessons/Units • Curriculum Guides • Technology-Based Materials	• Hands-On Learning • Student-Centered Learning • Cooperative/Group Learning • Technology-Based Strategies	• N/A

GENERAL DESCRIPTION

The Microcomputer-Based Laboratory Motion/Force Unit is a program that encourages and assists students to use electronic tools to generate data from the physical world and to use the data to construct their own meaning about scientific concepts.

Innovative Features: An important feature of the Motion/Force Unit is its award-winning software which makes it possible for students to carry on detailed and sophisticated analysis of data. One program innovation is that the students themselves are frequently the objects in motion, or are the source of the force that they study. Thus, students literally experience a visceral sensation of the concepts under study.

The program promotes a constructivist approach where the teacher's role moves from purveyor of knowledge to helper and facilitator — a learner among learners who suggests alternative questions and strategies of inquiry. Consequently, students construct their own scientific concepts while practicing important scientific processes and skills using electronic equipment.

Goals: The goals of of the program are to have students attain a Newtonian view of motion and force including a through comprehension of the concepts basic to distance, velocity, acceleration, and force; to improve student graphing and other science skills, particularly data analysis; and to have students practice working effectively and productively in small groups.

Effectiveness: The Motion/Force Unit has undergone rigorous evaluation and fine-tuning during its development. Thousands of high school and university students who have used the unit have made extraordinary gains in their comprehension of basic motion and force concepts as shown by their unit pre and posttest scores.

Source: *Promising Practices in Mathematics and Science Education* by the Laboratory Network Program. Philadelphia, PA: Research for Better Schools. 1993, 122-123.

TOOLS FOR SCIENTIFIC THINKING--FORCE MOTION–FORCE UNIT: A MICROCOMPUTER–BASED LABORATORY (continued)

NCISE Standards met:

☑ Accessible to all students.
☑ Build on students' prior experience and knowledge.
☑ Use an instructional model based on the scientific process such as: question, discover, create, communicate, and pursue new questions.
☐ Relate to personal and social needs.
☐ Select science concepts that are developmentally appropriate, with illustrative examples drawn from the content of multiple disciplines of science.
☑ Develop scientific thinking skills such as drawing conclusions based on evidence, using inference, creating models.
☑ Develop scientific habits of mind such as curiosity, skepticism, honesty, living with ambiguity.
☑ Use authentic assessments to chart teaching and learning.
☑ Shift the role of teacher from imparter of knowledge to designer and facilitator of learning.
☐ Seek relevant and significant applications of science content and concepts to students' personal and community life.

NCTM standards met:

☑ Pose tasks based on sound and significant mathematics.
☑ Build on students' prior experience and knowledge.
☑ Develop mathematics thinking skills that convince students of the validity of particular representations, solutions, conjectures, and answers.
☑ Engage students' intellect; pose questions and tasks that elicit, engage, and challenge each students' thinking.
☑ Develop students' mathematical knowledge and skills.
☑ Stimulate students to make connections and develop a coherent framework for mathematical ideas.
☑ Call for problem formulation, problem solving, and mathematical reasoning.
☑ Promote the development of all students' dispositions to do mathematics.
☑ Develop an instructional model based on the range of ways students learn mathematics.

RESOURCES/MATERIALS NEEDED FOR ADOPTION:

1. One copy of the Motion and Force Unit. This contains all necessary curricular materials for students. The unit may be copied along with a detailed teachers' curriculum guide and other important information concerning the use of microcomputer-based laboratories and the pedagogical ideas that inform the curricular materials.

2. One dynamics cart per station. (PASCO Scientific's Dynamics Cart ME-9430 is recommended.)

3. One pulley per station. (PASCO Scientific Super Pulley is recommended.)

4. One 8-foot-by-12-inch ramp per station. (The smoothest surface and most rigid material possible is recommended.)

Equipment Needed:

- Computer Equipment
- IBM Compatible
- Apple Computer
- Software
- Special Hands-On Equipment
- Macintosh Computer
- Vernier Software Motion Detector
- Vernier Force Probe
- Vernier Universal Lab Interface (If using MAC or IBM)
- QUEUE, Inc. Red Box (If using Apple II)

Support Needed:

- Orientation
- Staff Development
- Workshop/Inservice

Note: Experienced secondary physics teachers could implement this unit without any other support or assistance. However, other teachers contemplating the use of the unit might benefit from inservice training.

FUNDED BY: Federal Grants.

CONTACT:
Professor Ronald K. Thornton, Director
Center for Science and Mathematics Teaching
Tufts University
Medford, MA 02155
(Mail or Fax Inquiries Only)
Fax: (617) 627-3901

SITE(S):
Shrewsbury High School
Shrewsbury, MA

Source: The Regional Laboratory for Educational Improvement of the Northeast and the Islands

SECTION IV:
EFFECTIVE PROFESSIONAL DEVELOPMENT

Activity 8: Understanding Adult Learning 8-1

Activity 9: What Is Good Professional Development? 9-1

Activity 10: Alternative Models of Professional Development 10-1

Activity 11: Planning and Implementing Professional Development 11-1

Section IV: Effective Professional Development

The purpose of Section IV is to help participants deepen their understanding of adult learning and the characteristics of effective learning opportunities, and to broaden their vision of professional development beyond that of inservice workshops. Participants are also introduced to a model that can be used to plan long-term professional development for a school, district, region, or state. The activities are:

- **Activity 8: Understanding Adult Learning**. This activity encourages participants to analyze their own learning experiences as a way of deducing principles of effective adult learning.
- **Activity 9: What Is Good Professional Development?** In this activity, participants learn ten attributes of effective professional development programs and apply them to their own situations. They explore the shifting paradigm of professional development and its specific implications for designing opportunities to support reform in science and mathematics in classrooms, schools, and communities.
- **Activity 10: Alternative Models of Professional Development**. In this activity, participants examine six models of professional development and explore ways that they can be used for improving science and mathematics teaching.
- **Activity 11: Planning and Implementing Professional Development**. In this activity, participants develop and practice needs assessment strategies and are introduced to checklists for designing effective training sessions. They also work with a model for planning long-term professional development, which they apply to their current situation, and work through stages in the design process and identify what they need to pay particular attention to.

Section IV has been used in many situations, including:

- Teams from seven states, composed of state, intermediate unit, university, state board, governors' office, and major school district representatives, are working with their Eisenhower Mathematics and Science Regional Consortium on improving professional development opportunities for teachers of science and mathematics in their states. Institutes held during two consecutive summers used activities from Section IV to give them a common language about professional development, a framework for planning, and experiences with a number of different professional development models.

- An NSF-funded project is preparing 40 teacher leaders from schools in rural areas of a large southwestern state. Among the responsibilities of these leaders is to design and conduct professional development experiences for teachers in their schools, districts, and regions. During their summer leadership development institute, they participated in activities from Section IV, which provided them with design principles as well as specific strategies to expand their views of professional development beyond inservice workshops.

8

UNDERSTANDING ADULT LEARNING

Audience:

- Individuals responsible for planning and implementing professional development for science and mathematics educators at the building, district, regional, or state level.

Desired Outcomes for Participants:

- To identify features of effective learning that are common to all learners, and those (if any) that appear to be unique to or more important to adults in professional development contexts.

- To examine current professional development practices in light of the features of effective learning.

Materials:

- **Transparencies:**
  - *Analysis of Satisfying Learning Experiences* (8-10 and 8-11)
  - *Numbered Heads Together* (B-4-2)

- **Handouts:**
  - *Reflect and Write I* (8-12)
  - *Reflect and Write II* (8-13)
  - *Professional Development: Reflect and Write I* (8-14)
  - *Professional Development: Reflect and Write II* (8-15)
  - *Features of Effective Learning Experiences Summarized from the Literature* (8-16)
  - *Perspectives on Adult Learning* (8-17)

- Overhead projector and screen

- Newsprint, easels, markers, tape, blank paper, and pens or pencils

Time Required: One and one-half to three hours

Facilitator's Notes: You can approach this activity in three different ways. (See the Process Steps for an in-depth explanation of all three methods.) Method I focuses on demonstrating the common features of effective learning, whatever the age of the learner or the learning content. Method II focuses on contrasting learning experiences that are especially satisfying with those that are especially frustrating. Method III contrasts satisfying and frustrating *professional development* experiences. Methods I and II are likely to generate wide-ranging and rich discussion, but their outcomes are unpredictable. Method III, because it directs attention to similar types of learning situations, will be more likely to produce responses that follow fairly consistently the items on the handout **Features of Effective Learning Experiences (8-16)**.

A note about adult learning: There is a difference of degree between adults and children in a few areas. As people grow older, the efficiency of short term memory declines. The older we are, the harder it is to memorize quantities of information. Also, as people grow older, their network of information and experience grows larger. Thus, it takes longer to process new material into that network.

Process:

1. Form participants into groups of three to five. Explain that there can be no better experts to consult about adult learning than a group of adults who have been learning all their lives. Therefore, the most productive approach to the subject may be to first examine their own experience.

METHOD I

2. Distribute the handout **Reflect and Write I (8-12)**. Explain that the exercise asks them to consider learning experiences that stand out in their minds as particularly satisfying. Announce that they will have about ten minutes to think and write. The purpose of the writing is to stimulate thinking and provide notes for subsequent discussion. Participants will not be asked to read their notes, nor will notes be collected.

   Emphasize that the key word in the task assignment is *satisfying*. Thinking need not be limited to professional development or even to adult learning experiences. If someone's *most recent* satisfying experience was learning to ride a two-wheeler at age six, or taking a high school class in creative writing, for example, she should write about that experience. If someone's most satisfying *adult* learning experience was learning to knit or to speak Portuguese, he can write about that.

3. When the writing task is completed, ask participants to label the experiences they described as either professional development (PD), adult (but not professional development) (A), or pre-adult (P) experiences. Define "adult" for participants or ask them to agree on the dividing line between adult and pre-adult.

4. Ask each group to identify a recorder. Explain that group members are to tell their group what they wrote about. At the end of each "story," each group is to agree on how to describe the features that make the experience satisfying on newsprint under the appropriate heading (PD, A, or P). Use a separate sheet for each category.

   Tell the groups to also keep a tally on blank paper of the topics of learning listed according to the headings PD/A/P. Allow 15 to 25 minutes.

5. Distribute the handout **Features of Effective Learning Experiences Summarized from the Literature (8-16)**. Instruct the groups to compare their lists of features with the handout and:

   - letter each newsprint list to correspond with items on the handout; and

   - on each list circle the items, if any, that have no correlation on the handout.

   While groups are working, collect tallies on blank paper from each group and list on newsprint sheets the learning experiences that groups identified as falling in each learning category (PD, A, P). Tape the lists on the wall. When groups complete their task, tape the results on the wall beside the appropriate lists.

   You can complete discussion of one list before beginning the next, or you can complete small group work, tape up all results, then begin large group discussions.

6. Use the **Analysis of Satisfying Learning Experiences (8-10 and 8-11)** transparency for the content and the **Numbered Heads Together (B-4-2)** transparency (see **Appendix B-4**) to process the data collected.

   OR

   Focus a large-group discussion on some or all of these points:

   a. Which category contains the longest list of satisfying experiences? If not professional development, why not? If neither professional development nor adult experiences, why not?

b. How many of the topics are primarily science/mathematics in focus? How many contain elements of science or mathematics?

c. Do most of the lists contain most of the items on the handout **Features of Effective Learning Experiences Summarized in the Literature (8-16)**?

d. Are there any items from the handout **Features of Effective Learning Experiences Summarized in the Literature** that appear consistently on all lists – that seem to be critical to satisfaction? Are there any that rarely appear?

e. Are there items that appear on group lists as contributing to or even necessary for satisfaction that do *not* appear on the handout?

f. Do the lists differ? Does it seem that profiles of good professional development learning experiences differ significantly from good adult learning experiences and/or good pre-adult learning experiences?

g. Are there any "one-shot" experiences on the list (a workshop, for example)? How many of the experiences reported were in traditional classroom environments with a traditional instructor?

h. How well does this current "learning experience" model the features necessary for satisfying learning?

METHOD II

7. Form participants into groups of three to five. Distribute the handout **Reflect and Write I (8-12)**. Explain that the exercise asks them to consider learning experiences that stand out in their minds as particularly satisfying. Announce that they will have about ten minutes to think and write. The purpose of the writing is to stimulate thinking and provide notes for subsequent discussion. Participants will not be asked to read their notes, nor will notes be collected.

   Emphasize that the key word in the task assignment is *satisfying.* Thinking need not be limited to professional development or even to adult learning experiences. If someone's *most recent* satisfying experience was learning to ride a two-wheeler at age six, or taking a high school class in creative writing, for example, she should write about that experience. If someone's most satisfying *adult* learning experience was learning to knit or to speak Portuguese, he can write about that.

8. Distribute the handout **Reflect and Write II (8-13)**. This time, ask participants to choose a learning experience that they remember as particularly frustrating and to write about it. Allow another 10 minutes.

9. When the writing task is completed, ask participants to label the experiences *for both I and II* as either professional development (PD), adult (but not professional development) (A), or pre-adult (P) experiences. You may want to define "adult" for participants or ask them to agree on the dividing line between adult and pre-adult.

10. Ask each group to identify a recorder. First, have the group compile on blank paper a list of *satisfying* experiences and their labels (PD, A, or P) and a list of *frustrating* experiences and their labels.

    Second, explain that group members are to tell their group about their *satisfying* experience. At the end of each "story," the group is to agree on how to describe the features that made the experience satisfying, and record those features on newsprint. Suggest that, when features are mentioned by more than one person, they can check the feature mentioned as it is identified again. Allow 15 to 25 minutes.

11. While groups are working, collect lists on blank paper and make a list on newsprint of all *satisfying* experiences grouped according to type (PD, A, P). Tape the list on the wall. On a separate wall do the same for the *frustrating* experiences.

12. When group work is complete, tape newsprint sheets on wall and discuss briefly. Use METHOD I (Step 6) discussion points a, b, and g.

13. Complete Steps 9 and 10 for *frustrating* experiences. Allow 15 to 20 minutes.

14. Distribute the handout **Features of Effective Learning Experiences Summarized from the Literature (8-16)**. Give participants two or three minutes to read the handout, then ask them to consider first the *satisfying* experiences and identify features on the handout that

correspond with those on the newsprint lists. Have a volunteer letter the newsprint items as discussed. When all items have been considered, circle any items that have no correspondence on the handout. Discuss.

METHOD III

15. Form participants into groups of three to five. Distribute the handout **Professional Development: Reflect and Write I (8-14)**. Explain that the exercise asks them to consider professional development experiences that stand out in their minds as particularly satisfying. Announce that they will have about ten minutes to think and write. The purpose of the writing is to stimulate thinking and provide notes for subsequent discussion. Participants will not be asked to read their notes, nor will notes be collected.

16. Distribute the handout **Professional Development: Reflect and Write II (8-15)**. This time, ask participants to choose a professional development experience that they remember as particularly frustrating and to write about it. Allow another ten minutes.

    (Optional) You may want to focus the handout **Professional Development: Reflect and Write II (8-15)** exclusively on science and mathematics learning experiences.

17. Ask each group to identify a recorder. First, have the group compile on blank paper a list of *satisfying* experiences and a list of *frustrating* experiences.

    Second, explain that group members are to tell their group about their *satisfying* experience. At the end of each "story," the group is to agree on how to describe the features that made the experience satisfying, and record those features on newsprint. Suggest that, when features are mentioned by more than one person, they can check the feature mentioned as it is identified again. Allow 15 to 25 minutes.

18. While groups are working, collect lists on blank paper and make a list on newsprint of all *satisfying* experiences. Tape the list on the wall. On a separate wall do the same for the *frustrating* experiences.

19. When group work is complete, tape newsprint sheets on wall and discuss briefly. See METHOD I (Step 6) discussion points a, b, and h above.

20. Complete Steps 17 and 18 for *frustrating* experiences. Allow 15 to 20 minutes.

21. Distribute the handout **Features of Effective Learning Experiences Summarized from the Literature (8-16).** Give participants two or three minutes to read the handout, then ask them to consider first the *satisfying* experiences and identify features on the handout that correspond with those on the newsprint lists. Have a volunteer letter the newsprint items as discussed. When all items have been considered, circle any items that have no correspondents on the handout. Discuss.

22. Repeat the process described in Step 21 for the *frustrating* experiences.

23. Discuss implications. Do certain features seem to be key in creating frustration or satisfaction? Do lists identify the *absence* of certain features as sources of frustration? Does the positive list contain more of the features from the handout than the negative list? Do "one-shot" experiences show up more often on one list than the other? Do traditional educational methods appear more often on one list than the other? (Traditional = classrooms where students take notes while an instructor lectures.)

CONTINUE FOR ALL METHODS

24. Discuss some or all of the following points. As an option, write the questions on newsprint and ask participants to discuss them in their small groups and report out insights and observations.

    - How has this activity/discussion changed what you understood about adult learning, professional development, or effective learning in general?

    - Are there ways in which your current professional development plans could be improved to generate more satisfying and effective learning?

    - How well has this activity modeled the features of effective learning as described on the handout? How satisfactory has *this* learning experience been for you? (Is it a one-shot workshop or will participants have further contact with one another and other opportunities to work together on professional development?)

- What implications does this discussion have for your definition of systemic change? If the group has done **Activity 1: Framing the Dialogue Around Systemic Change**, refer them to Guidelines 3 and 5 in the reading, "Leading Through Systems Thinking." What are the implications of the guidelines for this exploration of adult learning? What are the "parts" of an effective learning system and how do they interact purposefully to function as a whole? Does an expanded view of learning influence your approach to changing the system? If so, how?

25. *(Optional)* Some adults want to know about theoretical approaches to adult learning. Refer them to the **Additional References** below (you may even want to jigsaw some of them) and/or pass out the handout **Perspectives on Adult Learning (8-17)** for review and dialogue. Possible discussion questions might include:

    - What else do you know about each of these four perspectives?
    - What has been your own experience with one or more of the perspectives?
    - From what you know about the *Toolkit* so far, what perspectives does it employ most? Least?

Additional References:

Abell, Sandra K. and Alice Krueger. February 1991. "Those Who Can *Do* Can Teach." *Science and Children* 28 (5): 32-33.

The planning and organization of problem-solving workshops for teachers are discussed. Suggestions for activities and anecdotes of teacher participation at workshops are provided.

Feuer, Dale and Beverly Geber. December 1988. "Uh-Oh . . . Second Thoughts About Adult Learning Theory." *Training* 25 (12): 31-39.

Fraser-Abder, Pamela. Winter 1992. "How Can Teacher Education Change the Downhill Trend of Science Education?" *Journal of Science Teacher Education* 3 (1): 21-26.

Knowles, Malcolm. August 1989. "Everything You Wanted to Know from Malcolm Knowles (and Weren't Afraid to Ask)." *Training* 26 (8): 45-50.

> In an adaptation from "The Making of an Adult Educator: An Autobiographical Journey," Malcolm Knowles, the father of adult learning theory, discusses motivation, self-directed learning, trainers and organization change, and social and economic inequalities in the United States.

______________. September-October 1992. "Applying Principles of Adult Learning in Conference Presentations." *Adult Learning* 4 (1): 11-14.

> Knowles' foundational principles of adult learning in making presentations are that (1) the audience should be active participants in a process of inquiry and (2) the process should build on the background, needs, interests, problems, and concerns of the audience.

Lawler, Patricia A. 1991. *Keys to Adult Learning: Theory and Practical Strategies*. Philadelphia, PA: Research for Better Schools.

> This publication is a guide to working successfully with adults based on research in the field and years of experience. It covers the characteristics of adult learners, how adults learn, and adult development. It then discusses six practical keys to success. Includes group activities.

Newton, Anne; Ken Bergstrom; Nancy Brennan; Kathy Dunne; Carol Gilbert; Nancy Ibarguen; Marla Perez-Selles; and Elizabeth Thomas. 1994. *Mentoring: A Resource and Training Guide for Educators.* Andover, MA: The Regional Laboratory for Educational Improvement of the Northeast and Islands.

Wiske, Martha Stone and Cynthia Y. Levinson. May 1993. "How Teachers are Implementing the NCTM Standards." *Educational Leadership* 50 (8): 8-12.

ANALYSIS OF SATISFYING LEARNING EXPERIENCES

- Which category contains more satisfying experiences? If not professional development, why not? If neither professional development nor adult experiences, why not?
- How many topics focus on science or mathematics? How many contain elements of science or mathematics?
- Do most of the lists contain most of the items on the Features of Effective Learning Experiences handout?
- Which items on the Features of Effective Learning Experiences handout appear on most or all lists? Which rarely appear?

ANALYSIS OF SATISFYING LEARNING EXPERIENCES (continued)

- Which items appear on most group lists and do not appear on the Features handout?
- Do the lists differ? Do good professional development experiences differ significantly from good adult learning experiences and/or good pre-adult learning experiences?
- Are there "one-shot" experiences on the list (e.g., a workshop)? How many experiences reported were in traditional classroom environments with a traditional instructor?
- How does this "learning experience" (Activity 8) model the features necessary for satisfying learning?

REFLECT AND WRITE I

Think of some learning experiences you have had that stand out in your memory as truly satisfying. Choose one of the most recent experiences.

What did you learn?

Spend a few minutes thinking and writing about what made that experience particularly satisfying.

REFLECT AND WRITE II

Think of some learning experiences you have had that stand out in your memory as especially frustrating. Choose one of the most recent experiences.

What did you learn (or what were you supposed to be learning)?

Spend a few minutes reflecting and writing about what made that experience particularly frustrating for you.

PROFESSIONAL DEVELOPMENT: REFLECT AND WRITE I

Think of professional development experiences you have had that were especially satisfying. Choose one.

What did you learn?

Spend a few minutes reflecting and writing about what made that experience particularly satisfying for you.

PROFESSIONAL DEVELOPMENT: REFLECT AND WRITE II

Think of some professional development experiences you have had that were especially frustrating. Choose one.

What did you learn (or what were you supposed to be learning)?

Spend a few minutes reflecting and writing about what made the experience particularly frustrating for you.

FEATURES OF EFFECTIVE LEARNING EXPERIENCES SUMMARIZED FROM THE LITERATURE

A. Learners help plan the learning experience to fit their needs.

B. New information is received through more than one of the five senses.

Learners may read text, hear an explanation, view a demonstration, use materials.

C. Learners process information in more than one context and in more than one way.

They may write in journals, analyze case studies, role play, hold small group discussions, conduct interviews or present lessons, solve problems, use art, music or movement to express ideas, manipulate materials, construct objects, etc.

D. Questions are thoughtfully and thoroughly discussed.

E. Learners are encouraged to reflect, wonder, suppose, predict.

F. New concepts and information are related to current knowledge and experience.

Learners may connect the new with the old by drawing on previous experience to illustrate new ideas; by comparing/contrasting new knowledge with previous knowledge; by applying new strategies/skills to familiar situations; by constructing metaphors for new concepts, etc.

Or new information may trigger a process – over time – of deconstructing previous knowledge, as is happening today as we rethink how science and mathematics describe the world, how they are practiced, and how they are learned.

G. The learning environment is collegial.

Learners learn from one another. Ideas and perspectives reflect the ethnic and gender diversity of the learners. Learners value and welcome diverse viewpoints.

H. Learners use new information over time, testing, comparing notes with other users, revising and refining understanding and practice.

I. Learners have access, when needed, to support and feedback from those whose expertise they respect.

J. Learners value what they are learning.

K. Learners experience success.

PERSPECTIVES ON ADULT LEARNING

Adult Learning Theorists . . .
say that adults became increasingly self-directed and their willingness and readiness to learn is stimulated by real life tasks and problems.

Stage Theorists . . .
say that individuals in different stages of development have different personal and professional needs.

Learning Styles Theorists . . .
say that individuals are different in the ways they perceive and process information and in the manner in which they most effectively learn.

CBAM Theorists . . .
say that as individuals learn new behaviors and change their practice, they experience different types of concerns that require different types of responses from professional developers.

9

WHAT IS GOOD PROFESSIONAL DEVELOPMENT?

Audience:

- Individuals responsible for planning and implementing professional development for science and mathematics educators at the building, district, regional, or state level.

Desired Outcomes for Participants:

- To identify the characteristics of effective professional development cited in research and documented in practice.
- To articulate and challenge professional and personal perspectives on what constitutes good professional development.
- To delineate new directions and strategies for professional development for systemic change.

Materials:

- **Transparencies:**
  - *Case Study Questions* (9-8)
  - *Three-Step Interview Professional Development Questions* (9-9)
  - *Sequential Research Review* (9-10)
  - *Collegiality and Collaboration* (9-11)
  - *Experimentation and Risk Taking* (9-12)
  - *Use of Available Knowledge Bases* (9-13)
  - *Participant Involvement* (9-14)
  - *Time* (9-15)
  - *Leadership and Sustained Support* (9-16)
  - *Appropriate Incentives and Rewards* (9-17)
  - *Application of Knowledge about Adult Learning and Change* (9-18)
  - *Integration of Individual, School, and District Goals* (9-19)
  - *Integration of Science, Mathematics, and Other Professional Development* (9-20)
  - *Characteristics of Effective Science and Mathematics Professional Development Programs* (9-21)
- **Handouts:**
  - *Case Studies # 1-3* (9-22 through 9-27, copied onto three different colors)
  - *Ten Critical Attributes of Effective Teacher Development Programs*
    - *Overview* (9-28 and 9-29)
    - *Collegiality and Collaboration* (9-30)

  - *Experimentation and Risk-Taking* (9-31)
  - *Incorporation of Available Knowledge Bases* (9-32)
  - *Appropriate Participant Involvement in Goal Setting, Implementation, Evaluation, and Decision Making* (9-33 and 9-34)
  - *Time to Work on Professional Development and Assimilate New Learnings* (9-35)
  - *Leadership and Sustained Administrative Support* (9-36)
  - *Appropriate Incentives and Rewards* (9-37)
  - *Application of Knowledge About Adult Learning and the Change Process* (9-38 and 9-39)
  - *Integration of Individual Goals with School and District Goals* (9-40)
  - *Formal Placement of the Program Within the Philosophy and Organizational Structure of the School and District* (9-41)
- *Inventory: Characteristics of Effective Professional Development Programs* (9-42)
- *Reflect and Write* (9-43)
- *Shifting the Paradigm of Professional Development* (9-44)

■ **Reading:**
- "A Paradigm Shift in Staff Development" by Dennis Sparks. *Education Week*, March 16, 1994, 13 (25): 42.

■ Overhead projector, screen, blank transparencies, and overhead pens

■ Newsprint, easels, markers, and tape

Time Required: Two to four hours

Facilitator's Notes: Often those with responsibility for science and mathematics are not in touch with the literature on effective professional development and have only their own, sometimes mediocre, experiences to inform their decisions. This exercise provides participants with an opportunity to learn about the characteristics of effective professional development and apply them directly to their own situations.

The activity has three parts. The first part, Case Study Analysis, is a good preliminary exercise for participants who have never been involved in planning or implementing professional development programs. Through examining case studies, they get a behind-the-scenes look at what goes into making professional development happen at the district level.

The second part of the activity, Critical Attributes of Professional Development, provides participants with a solid knowledge base for what constitutes good professional development.

This knowledge base is extended in the third part, A Paradigm Shift in Professional Development, in which participants who are veteran professional developers will be inspired by a new paradigm that is emerging to support systemic reform.

As facilitator, you will be able to select which parts of the activity to emphasize, given the experiences and responsibilities of the participants.

Process: CASE STUDY ANALYSIS

1. Tell the group that much goes on behind the scenes to plan for and implement professional development. Explain that they will examine a case study that tells the story of how a district dealt with professional development.

2. Randomly distribute the handouts **Case Studies # 1-3 (9-22 through 9-27)**, giving one copy of a case study to each person. Have participants with the same color handout form groups of three.

   Show the **Case Study Questions (9-8)** transparency. Explain that they will be asked to report out on one of the three questions. Allow 30 minutes to read their case study and dialogue about the questions.

3. As the groups work, post three newsprint sheets with the Case Study Questions as headers. After 30 minutes ask for three recorders to jot down responses to the questions as they come up. Randomly ask groups to report out alternating questions so that all three recorders are busy simultaneously.

   When reporting is finished, ask the groups to discuss any surprises, insights, or concerns.

CRITICAL ATTRIBUTES OF PROFESSIONAL DEVELOPMENT

4. Instruct participants in the Three-Step Interview technique (see **Appendix B-6**).

5. Show the **Three-Step Interview Professional Development Questions (9-9)** transparency. Read the questions to the group and instruct

them to follow the Three-Step Interview procedure while they ask the questions. Give pairs five minutes each to interview each other and then five minutes to report out, for a total of 15 minutes for the three steps of the process.

When the interview is over, have groups randomly report out changes in their notions of professional development, significant professional development activities, and their ideas about characteristics of good professional development programs that set them apart from those that are less effective.

Chart responses on newsprint.

6. Tell participants that they will now have a chance to examine the research and literature on what constitutes comprehensive professional development programs. They will do this review in ten groups, with each group looking at one of ten critical attributes. Divide them into ten groups. Give each group a copy of one critical attribute from the handout series **Ten Critical Attributes of Effective Teacher Development Programs (9-28 through 9-41)**.

   Use the **Sequential Research Review (9-10)** transparency to walk through the sequence with participants, explaining that each one of them will take turns reading out loud one paragraph of their section of the article.

   Have them dialogue about the content and relate it back to their personal experience.

   While they are working, pass out one blank transparency and overhead pen to each group as well as one copy of that group's transparency **(9-11 through 9-20)**. In other words, the group that is reading from "Collegiality and Collaboration" on the first critical attribute would also get that transparency, **Collegiality and Collaboration (9-11)**. Tell them that at the end of 15 minutes they will report out on their attribute in a creative way. For example, they can use role playing, develop a transparency of their own, use the transparency given to them, or make charts or pictures on newsprint and use these to report out.

7. Put the **Characteristics of Effective Science and Mathematics Professional Development Programs (9-21)** transparency on the overhead. Distribute the handout **Inventory: Characteristics of Effective Professional Development Programs (9-42)** to each participant. Explain that after each attribute is described by its

group, they should note where the programs they are involved in fall on the continuum.

Check off the first attribute and ask the group that has **Collegiality and Collaboration** to share with the rest of the group what they learned from their reading. Pause after each one so participants can "inventory" it. Go through each of the ten critical attributes in this way.

Once each group has reported out, distribute a full set of the handouts **Ten Critical Attributes of Effective Teacher Development Programs (9-28 through 9-41)**, including the overview to each participant for their own future reference.

8. Ask participants to refer to the handout **Inventory: Characteristics of Effective Professional Development Programs (9-42)** and indicate by raising their hands which three characteristics create the greatest challenges for them. Tally on a transparency.

9. Designate discussion groups for each of the most challenging characteristics. Participants select which group to work in. Ask them to discuss: How have they or might they address this challenge in science and mathematics professional development? Ask them to record their ideas on newsprint.

   Have the groups report out. Others may add their ideas to the newsprint.

10. Ask participants to look back at their definition of systemic change developed in **Activity 1: Framing the Dialogue Around Systemic Change**. Where does professional development show up in their definition? Are there any attributes of effective professional development that help make connections to any other part of the system (or that are also attributes of another part)? For example, collaboration is critical to organizational development, as it is to systemic reform in general; a vision of successful learning can and should involve learning for adults as well as for young people, etc.

    Ask them to consider any changes or additions they would make to their definition of systemic change.

A PARADIGM SHIFT IN PROFESSIONAL DEVELOPMENT

11. Explain to participants that like many domains in education, professional development is going to change profoundly over the coming years. Ask them to talk in groups of three or four about

changes they have already witnessed. Ask a few groups to report out.

12. Distribute the handout **Reflect and Write (9-43)** to each participant. Have them work individually, reading each statement and jotting down their thoughts. After ten minutes ask participants to dialogue in their groups about what they wrote.

13. Explain that the excerpts in the handouts were taken from an article written by Dennis Sparks (Executive Director of the National Staff Development Council) for *Education Week*. Distribute the reading "A Paradigm Shift in Staff Development" and give the groups time to discuss the following questions after reading it.

    - In what ways could the changes described in the article change how they design and implement professional development?
    - What changes are the most exciting? Why?
    - How have the three powerful ideas – results-driven education, constructivism, and systems thinking – impacted their school, district, region, or state in areas other than professional development?

14. In the same groups, ask participants to brainstorm the "elements" of a professional development system (some of which are noted in the Sparks article, e.g., time, location, responsibility). After three minutes ask for one system element from each group and record on newsprint. Go around a second time if groups still have elements to add.

15. Divide up the elements by the number of groups and assign an equal number of elements to each group. Have each group make a continuum for their element on newsprint and describe past, present, and future as best they can. Explain that the "future" category is what professional development could be.

16. Have all the system element continuums taped up around the room and encourage a "station-to-station" gallery tour.

17. Distribute the handout **Shifting the Paradigm of Professional Development (9-44)** for the groups to review and connect to their own continuums. Note that this chart is an elaboration of the elements from the Sparks article. Ask them to review their

definitions of systemic change from **Activity 1: Framing the Dialogue Around Systemic Change**. Has this activity stimulated any changes? Any elaborations?

18. Ask participants to reflect on, talk about, and/or write: What have I learned in this activity? How can I use what I've learned?

Additional References:

Arbuckle, Margaret A. and Lynn B. Murray. 1989. *Building Systems for Professional Growth: An Action Guide*. Andover, MA: The Regional Laboratory for Educational Improvement of the Northeast and Islands.

Darling-Hammond, Linda. June 1993. "Reframing the School Reform Agenda: Developing Capacity for School Transformation." *Phi Delta Kappan* 74 (10): 752-761.

Fullan, Michael G. 1990. "Staff Development, Innovation, and Institutional Development." In Bruce Joyce, ed., *Changing School Culture Through Staff Development*, 1990 Yearbook of the Association for Supervision and Curriculum Development. Alexandria, VA: ASCD.

Little, Judith Warren. Summer 1993. "Teachers' Professional Development in a Climate of Educational Reform." *Educational Evaluation and Policy Analysis* 15 (2): 129-151.

Loucks-Horsley, Susan; Catherine Harding; Margaret A. Arbuckle; Lynn B. Murray; Cynthia Dubea; and Martha K. Williams. 1987. *Continuing to Learn: A Guidebook for Teacher Development*. Andover, MA: The Regional Laboratory for Educational Improvement of the Northeast and Islands.

Shanker, Albert. 1990. "Staff Development and the Restructured School." In Bruce Joyce, ed., *Changing School Culture Through Staff Development*, 1990 Yearbook of the Association for Supervision and Curriculum Development. Alexandria, VA: ASCD.

CASE STUDY QUESTIONS

1. How is the case study scenario similar to or different than practices you have experienced or observed?

2. What strategies were effective?

3. What strategies needed rethinking or redirecting?

THREE-STEP INTERVIEW PROFESSIONAL DEVELOPMENT QUESTIONS

1. How has your notion of what constitutes good professional development changed over the years?

2. What significant professional development activity(ies) have you planned or participated in?

3. What sets good professional development programs apart from those that are less effective?

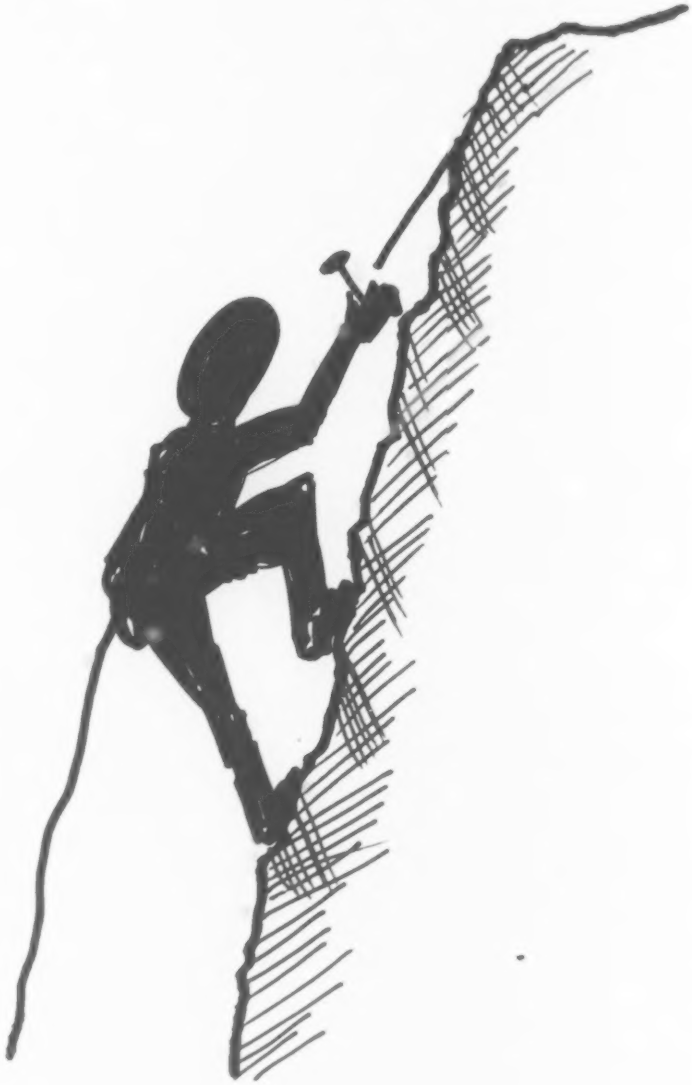
SEQUENTIAL RESEARCH REVIEW

- Take turns READING your section of the article OUT LOUD (one paragraph each).
- DIALOGUE about the content and your personal experience.
- REPORT OUT major points and personal perspectives.

COLLEGIALITY AND COLLABORATION

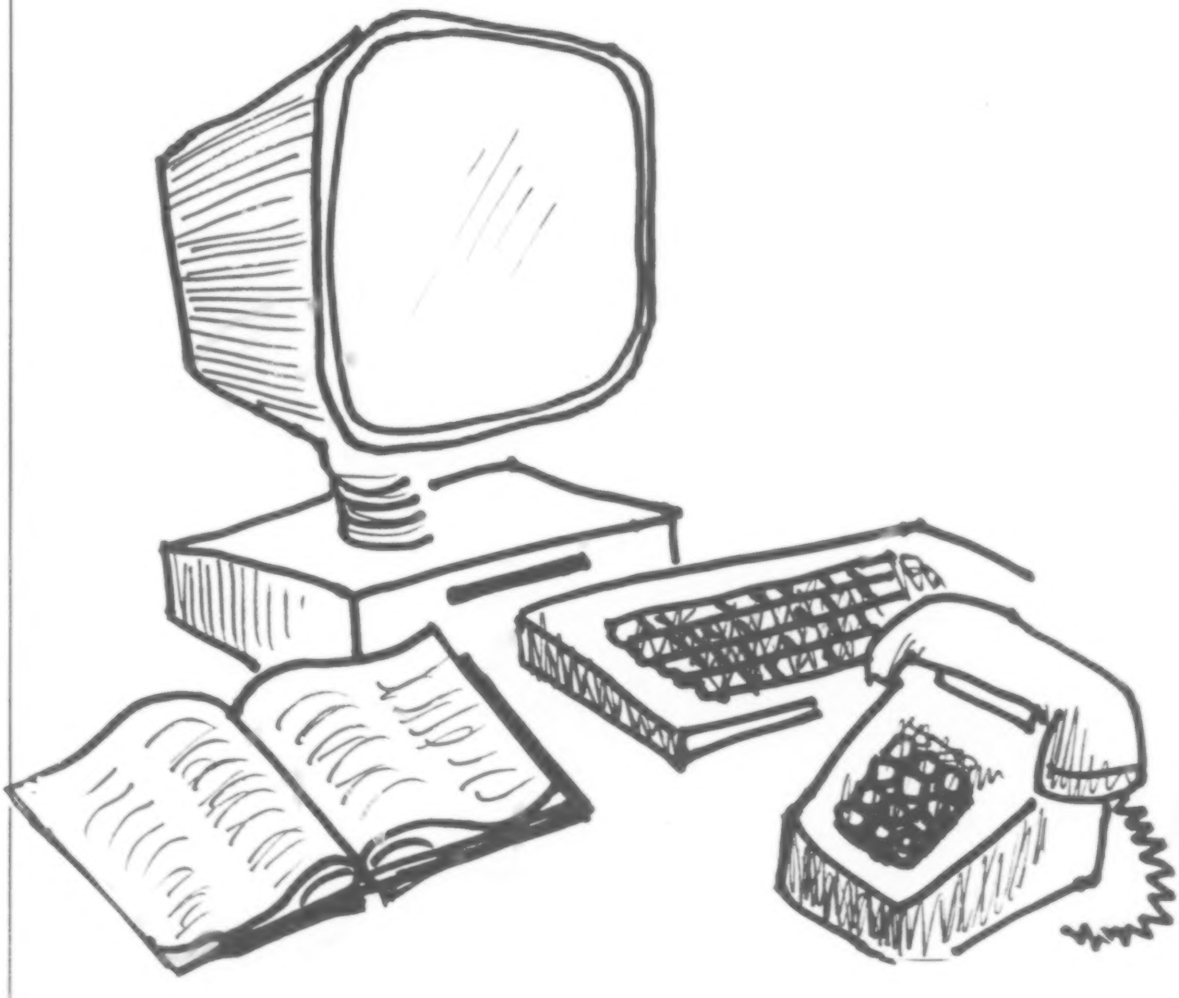
Source: *Building Systems for Professional Growth: An Action Guide* by Margaret A. Arbuckle and Lynn B. Murray. Andover, MA: The Regional Laboratory for Educational Improvement of the Northeast and Islands. ©1989, 2-27.

EXPERIMENTATION AND RISK TAKING



Source: *Building Systems for Professional Growth: An Action Guide* by Margaret A. Arbuckle and Lynn B. Murray. Andover, MA: The Regional Laboratory for Educational Improvement of the Northeast and Islands. ©1989, 2-29.

USE OF AVAILABLE KNOWLEDGE BASES



Source: *Building Systems for Professional Growth: An Action Guide* by Margaret A. Arbuckle and Lynn B. Murray. Andover, MA: The Regional Laboratory for Educational Improvement of the Northeast and Islands. ©1989, 2-31.

PARTICIPANT INVOLVEMENT

Source: *Building Systems for Professional Growth: An Action Guide* by Margaret A. Arbuckle and Lynn B. Murray. Andover, MA: The Regional Laboratory for Educational Improvement of the Northeast and Islands. ©1989, 2-33.

TIME

12
1
2
3
4
5
6
7
8
9
10
11

Source: *Building Systems for Professional Growth: An Action Guide* by Margaret A. Arbuckle and Lynn B. Murray. Andover, MA: The Regional Laboratory for Educational Improvement of the Northeast and Islands. ©1989, 2-35.

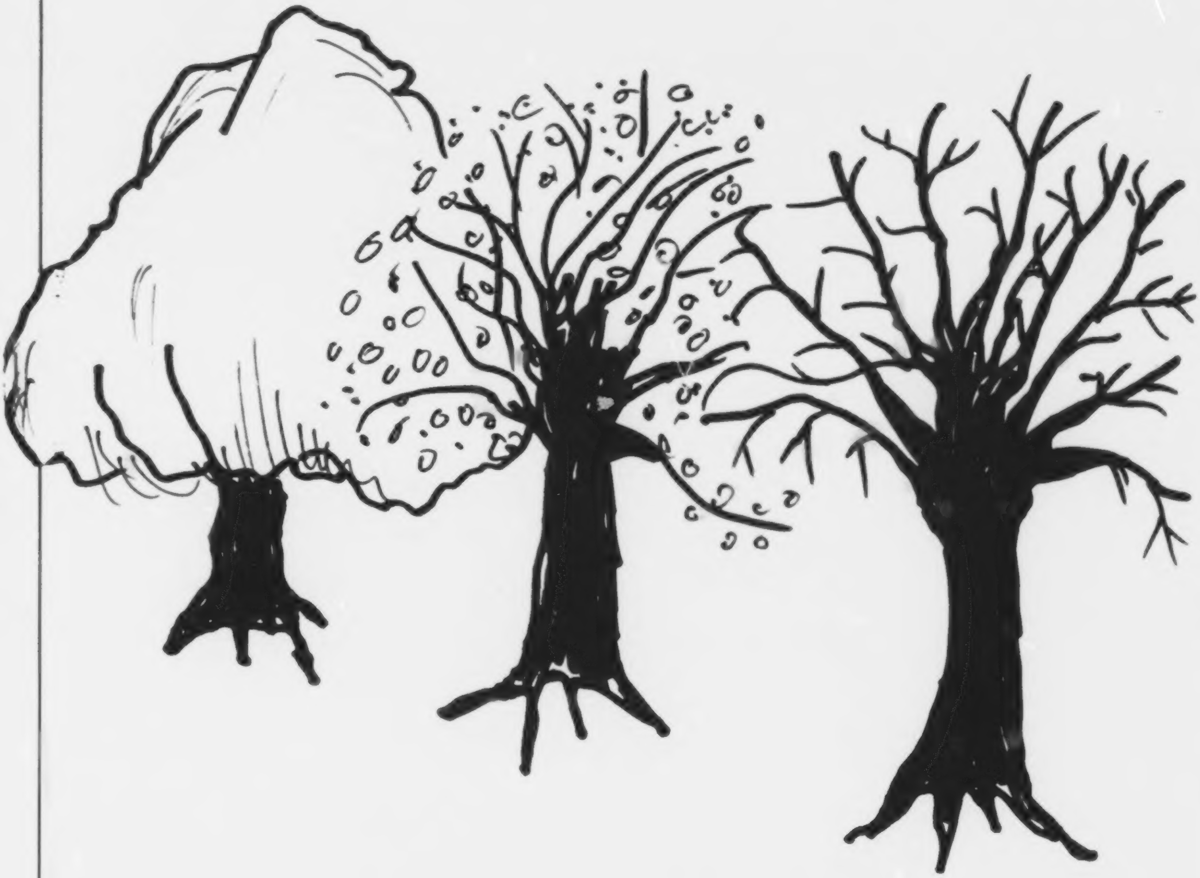
LEADERSHIP AND SUSTAINED SUPPORT

Source: *Building Systems for Professional Growth: An Action Guide* by Margaret A. Arbuckle and Lynn B. Murray. Andover, MA: The Regional Laboratory for Educational Improvement of the Northeast and Islands. ©1989, 2-37.

APPROPRIATE INCENTIVES AND REWARDS

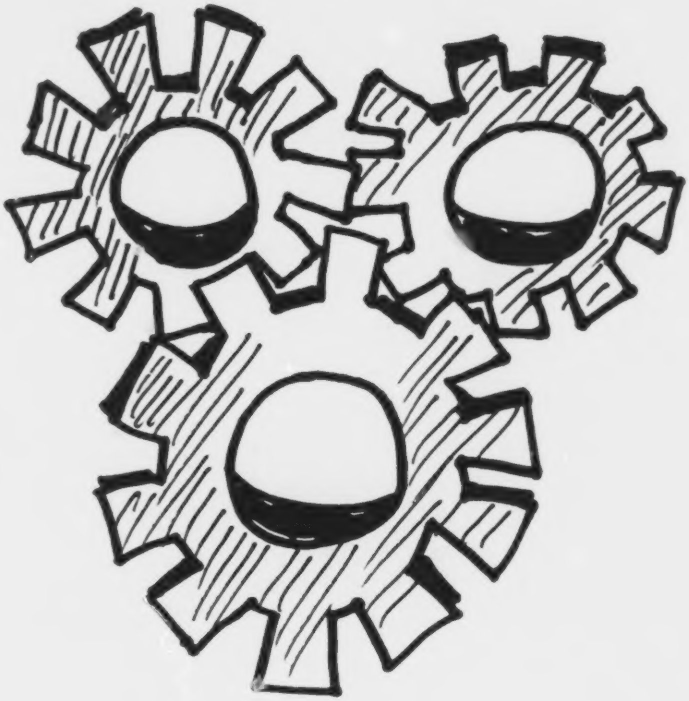
Source: *Building Systems for Professional Growth: An Action Guide* by Margaret A. Arbuckle and Lynn B. Murray. Andover, MA: The Regional Laboratory for Educational Improvement of the Northeast and Islands. ©1989, 2-39.

APPLICATION OF KNOWLEDGE ABOUT ADULT LEARNING AND CHANGE



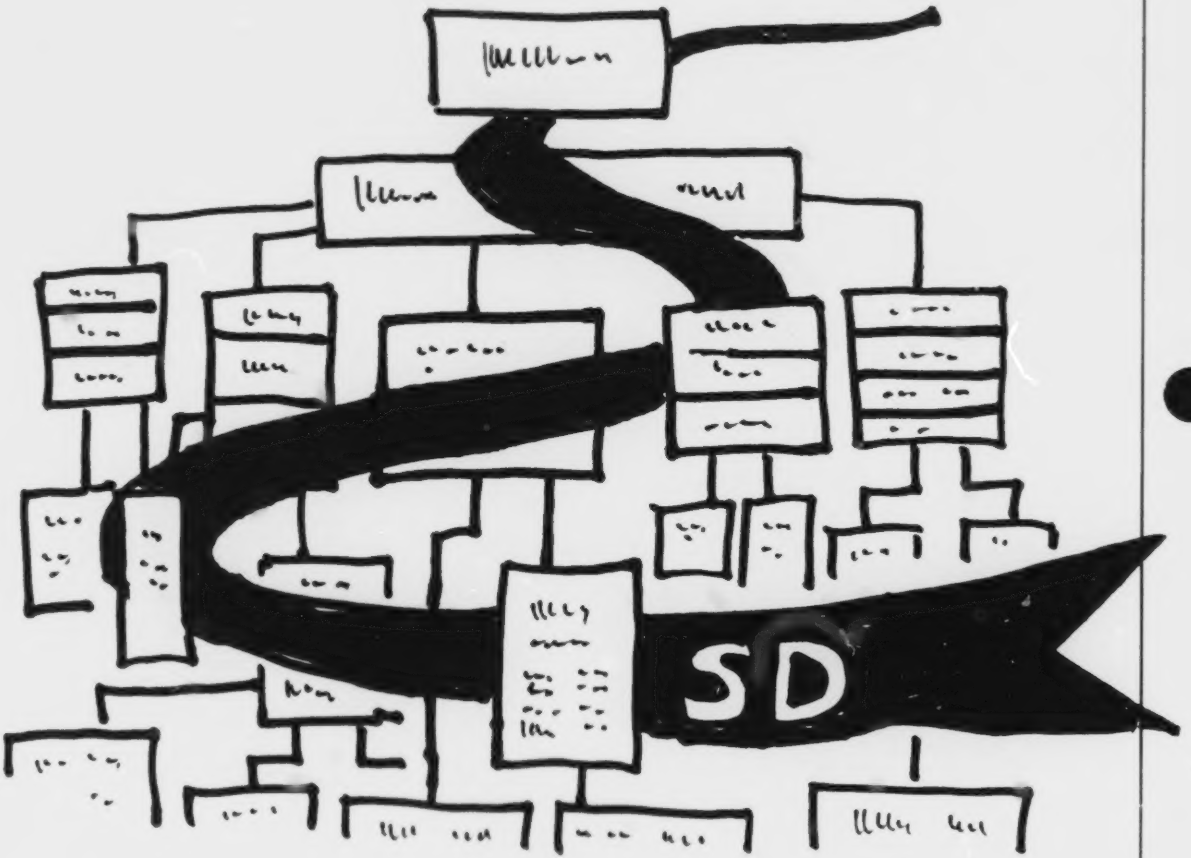
Source: *Building Systems for Professional Growth: An Action Guide* by Margaret A. Arbuckle and Lynn B. Murray. Andover, MA: The Regional Laboratory for Educational Improvement of the Northeast and Islands. ©1989, 2-41.

INTEGRATION OF INDIVIDUAL, SCHOOL, AND DISTRICT GOALS



Source: *Building Systems for Professional Growth: An Action Guide* by Margaret A. Arbuckle and Lynn B. Murray. Andover, MA: The Regional Laboratory for Educational Improvement of the Northeast and Islands. ©1989, 2-43.

INTEGRATION OF SCIENCE, MATHEMATICS, AND OTHER PROFESSIONAL DEVELOPMENT



Source: *Building Systems for Professional Growth: An Action Guide* by Margaret A. Arbuckle and Lynn B. Murray. Andover, MA: The Regional Laboratory for Educational Improvement of the Northeast and Islands. ©1989, 2-45.

CHARACTERISTICS OF EFFECTIVE SCIENCE AND MATHEMATICS PROFESSIONAL DEVELOPMENT PROGRAMS

1. Collegiality and collaboration
2. Experimentation and risk taking
3. Use of available knowledge bases
4. Participant involvement in appropriate aspects
5. Time to participate and practice
6. Leadership and sustained support
7. Appropriate incentives and rewards
8. Application of knowledge about adult learning and change
9. Integration of individual, school, and district goals
10. Integration of science and mathematics professional development with other professional development and organizational development activities

Source: *Building Systems for Professional Growth: An Action Guide* by Margaret A. Arbuckle and Lynn B. Murray. Andover, MA: The Regional Laboratory for Educational Improvement of the Northeast and Islands. ©1989, 2-25.

CASE STUDY #1
Mountain View Elementary School

The newly hired assistant principal of Mountain View School, a large urban elementary school, was a champion of professional development. She had been very involved in professional development as a teacher leader in her previous position. She knew what had worked and what hadn't and was eager to act on her knowledge. She had also recently completed a challenging masters degree program and arrived on the job filled with ideas, enthusiasm, and knowledge about recent research on education and on professional development. The principal of the school was less informed but shared a deep belief in the importance of continued professional development of all staff.

At this point professional development at Mountain View consisted of an occasional districtwide activity mandated by the central office. The staff were uninvolved in professional development, knew little about what it could be, and didn't care. They were also involved in a contract dispute. Nonetheless, the champions pushed onward.

To help the staff learn more about professional development possibilities, they gave everyone a collection of readings on learning research, neatly bound in three-inch binders. They hoped for stimulating and meaningful discussion with the staff. Instead the teachers resented the readings, didn't know the purpose of the information, and were intimidated by the size of the notebooks. Being sensitive to the concerns of the teachers, the administrators decided to hold an open forum to air concerns. It resulted in a gripe session about things over which the administrators had no control. They had, with the best of intentions, created a white elephant.

The administrators knew a lot about successful professional development, but had absolutely no idea how to make it happen. They sought assistance from the director of the statewide professional development network. Through discussion with her and reading of information on the *processes* of professional development – as opposed to the *content* – they began to formulate a plan to remedy the situation they had created. Their first step was to educate the staff about professional development (*not* research on learning). With low morale, a tight teacher contract, no money, and only one inservice day left in the year, doing this was going to be a challenge. They decided to use half of the allocated inservice day for a series of mandated activities that got the staff reading, thinking, and talking about professional development. The design infused new information from recent research and built on the teachers' experiences with professional development. It acknowledged the legitimacy of their experiential knowledge as well as knowledge from external sources.

Source: Building Systems for Professional Growth: An Action Guide by Margaret A. Arbuckle and Lynn B. Murray. Andover, MA: The Regional Laboratory for Educational Improvement of the Northeast and Islands. ©1989, 1-11 through 1-12.

CASE STUDY #1 (continued)

The assistant principal felt strongly about the importance of involving the entire staff in this initial educating phase and was willing to risk the repercussions of a mandated day. She wanted the staff to determine how to proceed with professional development, but also wanted them to have a more enlightened vision of what it might look like before giving them that responsibility. The half-day inservice was conducted by an elementary teacher from a neighboring district who was a skilled and experienced professional developer. She was credible, could relate to the teachers' concerns, and was well suited to handle a potentially volatile situation. The administrators participated fully as learners. The outcome was overwhelmingly positive. The session closed with a request for volunteers to serve on a design team to actually create a professional development system for their school. Twenty-one teachers volunteered.

A brief after-school meeting was conducted by the teacher consultant to review for the design team and interested others the basic elements of a structure for professional development and steps to develop one. Seventeen teachers attended. Eleven of them then developed a proposal for funds from the district professional development team to support a summer work retreat to develop their system. When this proposal was presented for approval, eleven other teachers attended to signal their support.

The proposal was approved and a summer session scheduled. By now, the numbers were up to 24. The incentive for involvement was certainly not money; only $25 per day per teacher had been requested. Their primary motivation was simply to influence the design of professional development opportunities in their school. They were on their way.

CASE STUDY #2
West Orange School District

The West Orange School District was considered one of the best in the state. Its proximity to the coast, easy access to several large cities, and rural location made it a very desirable spot indeed. The school staff was stable, experienced, knowledgeable, and very professional.

The district had developed a five-year professional development plan, as required by the state. The plan, which consumed many pages, clearly outlined the organizational structure for professional development, defined a mission statement, described districtwide goals and action plans to meet them, and presented a timeline. It was a tidy package. The group with primary responsibility for professional development was a district professional development team composed of "professional development leaders" from each building, the central office, and parent association.

Something was lacking, however. The plan didn't touch the heart of professional development, nor the staff. It was a hollow document that had meaning only to the few who had written it. Although the district team had been formed, their role was unclear. Most of the activities were districtwide, most of the proposed activities were still sitting on paper, the needs assessment was outdated, and isolated, fragmented workshops continued to be the major vehicle for professional development.

The assistant superintendent, formerly a principal and a teacher in the district, recognized that it was a plan on paper only. It didn't come close to matching his vision of what professional development should be. He believed in the importance of an integrated, coordinated, districtwide system, but recognized and valued the diversity of the schools. He also believed firmly in teacher involvement as decision makers. He was an ardent champion of professional development and a voracious searcher of knowledge (an "omnivore," as Bruce Joyce would say), for himself as well as the staff. He knew that good decisions would not be made if the staff were not educated about professional development.

Shortly after the district team was formed, the assistant superintendent held a two-day retreat with a nationally known consultant to familiarize team members with effective professional development practices. This was the start of an ongoing process of continuing education. Information about how to create a framework to nurture and support these good practices, however, was still lacking. He and the team knew what they wanted, but didn't know how to get there.

Source: *Building Systems for Professional Growth: An Action Guide* by Margaret A. Arbuckle and Lynn B. Murray. Andover, MA: The Regional Laboratory for Educational Improvement of the Northeast and Islands. ©1989, 1-13 through 1-14.

CASE STUDY #2 (continued)

To further his own education, the assistant superintendent attended the National Staff Development Council conference and read *Continuing to Learn: A Guidebook for Teacher Development.* He sought out one of the authors, who met with him and the co-chairs of the district professional development team. The purpose was to examine the current state of affairs and to lay out a plan for what needed to happen. The outcome was a plan jointly developed and strongly endorsed by all parties. It was a good fit.

A three-day summer retreat was then planned to revisit successful professional development practices, develop a "living" mission statement, and develop a management plan which reflected knowledge of effective practices. The intent was not only to rebuild a more meaningful organizational structure for staff development in West Orange, but also for the school leaders to experience a process for developing a system which they could, in turn, apply in their own buildings. This was accomplished very successfully. A follow-up day was devoted more specifically to the application of the district system at the building level and the development of individual building-based professional development systems. They were well on their way to implementing an integrated building-based system for professional development.

CASE STUDY #3
Conversations . . .
The Start of Change at Skowhegan Area High School

> *The most important vehicle for maintaining an organization and creating a notion of change is to encourage conversation.*
>
> – John Peper, 1990

Teachers at Skowhegan Area High School are asking questions, exploring alternatives, debating issues, reading articles, visiting other schools, inviting community members to join in discussions, talking with students about educational issues . . . encouraging conversation.

During these times of decreasing funds, and with talk about schools not doing the job of preparing students for the future, how does the staff at Skowhegan Area High School remain positive and progressive? By keeping the lines of communication open. By drawing upon the strength and power that can be gained through the sharing of ideas and the exploration of new concepts, and by working together to be part of the solution, not part of the problem.

What was the catalyst that initiated conversation? A carefully planned and structured workshop day in November. Eighty staff members joined together to "engage in conversation." Working in groups of five (structured so that no two teachers from the same department were together), the day began with a warm-up activity that encouraged discussion about quotes pertaining to change and the future. After an overview of the change process and the agenda for the day, ground rules were established for participation during the day.

Five articles focusing on different faces of "The Future of the High School" were read, discussed, and taught to each other during a three-hour cooperative learning "jigsaw" activity. After lunch teachers engaged in a "Forced Choice" activity that required each of them to go public with their beliefs and to listen to the beliefs of others. They then discussed the conditions they felt were necessary for effective change to occur. The day ended after teachers completed an inventory sheet that related our current status with regard to the "Ten Attributes for Successful Teacher Development Programs."

Source: Reprinted with permission of The Western Maine Partnership from *The Western Maine Partnership Bulletin* by Barbara Arnold, Principal, Skowhegan Area High School. ©1992, 9.

CASE STUDY #3 (continued)

This day, although simple in nature, has had powerful and long lasting effects. . . . As a staff member observed, "The fallout is really profound . . . faculty are thinking and talking about professional issues all the time."

"Substantive talk" continues, and since the November workshop, 24 school board members, parents, business leaders, and students have joined the faculty in ongoing conversations about the future of Skowhegan Area High School. This is the beginning of a strategic visioning and planning process and we are confident that our "committee of the whole" will achieve it.

TEN CRITICAL ATTRIBUTES OF EFFECTIVE TEACHER DEVELOPMENT PROGRAMS

OVERVIEW

1. Collegiality and collaboration
2. Experimentation and risk taking
3. Use of available knowledge bases
4. Appropriate participant involvement in goal setting, implementation, evaluation, and decision making
5. Time to work on professional development and assimilate new learnings
6. Leadership and sustained administrative support
7. Appropriate incentives and rewards
8. Application of knowledge about adult learning and the change process
9. Integration of individual goals with school and district goals
10. Formal placement of the program within the philosophy and organizational structure of the school and district

Teacher development is a complex process whose success depends upon both a favorable context for learning and practical, engaging activities. Availability of resources, flexible working conditions, support, and recognition can make all the difference in the desire of teachers to refine their practice. Similarly, professional development experiences that build on collegiality, collaboration, discovery, and solving real problems of teaching and learning summon the strength within a staff, instead of just challenging them to measure up to somebody else's standard. The focal point for professional development is the individual, working with others, trying to do the best possible job of educating children. When professional development emphasizes an idea or an approach without considering the person(s) who will implement it, the design and results are weakened.

Since professional development and school improvement efforts are personal experiences shaped by the players and circumstances involved, they belie tidy recipes for success.

Source: *Continuing to Learn: A Guidebook for Teacher Development* by Susan Loucks-Horsley et al. Andover, MA: The Regional Laboratory for Educational Improvement of the Northeast and Islands. ©1987, 7-8.

OVERVIEW (continued)

They are more than just training designs; they are the net result of planning, trial and error, assessing results, and sustaining commitment to improvements. Yet we can identify certain characteristics that underlie most, if not all, successful change efforts. These relate to both the climate for growth in a school and the activities pursued in the name of professional development. Figure 1 *[the list on the previous page]* lists these characteristics, and the following elaboration shows how each plays out in staff development programs.

These attributes of successful professional development consider the learner(s), the challenge, the reward, and the difference a program or process can make. They are not ordered or tightly integrated as factors, but the absence of any one of them has the power to sink the ship. Together they support and sustain a community of learners.

COLLEGIALITY AND COLLABORATION

Pointing to the need for collaborative professional development in schools, Carl Glickman (1986) refers to the "one-room school" syndrome. It's a tradition of isolationism created long ago when teachers literally worked alone in one-room schools. While we have increased personnel, we have not always connected staff in schools for purposes of sharing expertise, solving problems, and pursuing improvement. Creating collegial or collaborative relationships is a vital strategy for supporting individual and organizational change.

Collegiality is more than congeniality; it means connecting on a professional level with other school staff, looking for new ideas, advice, a forum to test models of teaching (Little 1982, Lortie 1975). Collaboration relates to mutual problem solving, assuming that multiple perspectives are better than single ones. It can increase collective understanding, strengthen a sense of common mission, and buoy individuals who might otherwise be swamped by the demands of facing children alone in the classroom.

In a school where collegiality and collaboration are norms, the staff recognizes its resourcefulness. Teachers and administrators understand teaching to be a craft, actively learned on the job and eminently worth talking about. They build a common language about teaching, with the focus on practice rather than on teachers or students (Lieberman 1986). In such settings, teachers as well as administrators are actively involved in planning as well as participating in professional development experiences. The principal models collegiality by engaging in activities rather than just sanctioning them. The collective enterprise of professional development removes the stigma from an individual's improvement activities. Everyone has something to learn, and everyone can benefit from another's experience.

Source: *Continuing to Learn: A Guidebook for Teacher Development* by Susan Loucks-Horsley et al. Andover, MA: The Regional Laboratory for Educational Improvement of the Northeast and Islands. ©1987, 8-9.

EXPERIMENTATION AND RISK TAKING

A recent article on professional growth notes that one of the major misconceptions about teaching, found both inside and outside the profession, is that teaching is a relatively commonplace, easy-to-learn task (Wildman and Niles 1987). This attitude leads people to believe that teachers are either born mysteriously into the profession or hatched in teacher education programs. What this perspective ignores is the complexity of learning to teach real kids in imperfect environments.

Methods may be starting points, but they don't cover the tremendous range of classroom situations and responses from students. Teachers constantly adjust their techniques and goals as they work. The classroom is a living laboratory, requiring experimentation and risks, moving from comfortable frames of reference to breaking new ground.

The ability to take the risks necessary to teach well, and to find support in failure as well as in success, demands a trusting environment for learning. For teachers as well as for students, trying something new often means initially experiencing discomfort. It may mean getting worse before getting better. The perseverance needed to get beyond adequate performance to efficient, graceful form can be staggering. Teachers need to feel comfortable with their discomfort, knowing that they are supported in their growth.

Source: *Continuing to Learn: A Guidebook for Teacher Development* by Susan Loucks-Horsley et al. Andover, MA: The Regional Laboratory for Educational Improvement of the Northeast and Islands. ©1987, 9-10.

INCORPORATION OF AVAILABLE KNOWLEDGE BASES

Saphier and King (1985) write:

> *There are generic knowledge bases about teaching skills and how students learn; about teaching methods in particular areas; about young people's cognitive and affective development; and about each of the academic disciplines. These knowledge bases are practical, accessible, and very large. Teachers and supervisors are continually reaching out to them to improve their teaching and supervision (2).*

While most agree that there are indeed substantial knowledge bases from which teachers can draw, we have seen few indications that most teacher do, as Saphier and King claim. For whatever reasons – and there are many that are not the fault of teachers – what is known from research and sound practice is *not* fed continuously into classroom practice (Huberman 1983). But it is an important element of strong professional development programs. While curiosity and eagerness to learn more effective ways of teaching characterize the openness in the teaching profession, good professional development takes advantage of this curiosity and promotes disciplined inquiry into important areas of teaching and learning.

Knowledge useful to teachers may be documented in research or validated in model programs and practices; both sources inform teaching. The strongest position sees teachers contributing to as well as using knowledge bases. If knowledge is something somebody else has and there's no bridging to or extending beyond it, then the learner remains removed and passive.

Research and model practices can stimulate reflection, discussion, and a desire to improve. They can provide guidance and direction for changing practice in ways that increase student learning. They should not, however, be used as a definition of how all teachers must behave in the classroom (Good and Weinstein 1986) or as a cure-all for perceived deficiencies in the profession (Zumwalt 1986). As Zumwalt says, "the potential of research to improve education does not come by generating rules of practice but rather from informing the deliberations of teachers and from encouraging similar inquiry from them" (2).

Source: Continuing to Learn: A Guidebook for Teacher Development by Susan Loucks-Horsley et al. Andover, MA: The Regional Laboratory for Educational Improvement of the Northeast and Islands. ©1987, 10.

APPROPRIATE PARTICIPANT INVOLVEMENT IN GOAL SETTING, IMPLEMENTATION, EVALUATION, AND DECISION MAKING

Teachers are always involved in their own development, but the degree to which they are invested in their own and their system's improvement is often limited. Many times teachers are enrolled in workshops that supervisors deem necessary. They neither engage in the question of need nor the search for viable solutions. When the time comes to evaluate a training workshop, it is the content they are asked to evaluate; rarely are they given an opportunity to validate the appropriateness of the program given their knowledge, their experience, and their questions about student learning. Furthermore, they contribute little to the application of the practice in their classrooms – the tailoring that is so necessary if such practices are to foster improvements.

This is professional development in spite of the participants rather than for them. It also misses an opportunity to enlist teachers in the development of the school and district.

Good professional development recognizes the validity of the individual as well as the community to which that person belongs. It seeks to engage participants in as many decision points as possible. Yet it acknowledges that the teacher's major purpose is to teach students, not to serve on committees and respond to questionnaires and surveys seeking input and involvement in every decision being made. Thus effective professional development programs vary the kinds of involvement they seek from individual teachers, depending on the goals and the approaches taken.

Sometimes teachers share responsibility for planning, implementing, and evaluating professional development activities. Other times individuals assess their own needs, identify goals, arrange activities, evaluate their learning, and plan for another cycle of development. Still other times teachers participate in training arranged by a committee or a concerned administrator. While such training may be voluntary, there are also cases where participation is mandatory. In such case, success relies on the care with which the particular training was chosen (i.e., that it fits the improvement needs of teachers), the ability of the trainer or presenter to relate to the classroom realities of the participants and allow for reflection on the best applications, the soundness of the content being presented, and the amount of help and support available to teachers to implement the new practices.

Research and practice have shown that, even when teachers are not involved in decisions leading up to a training program, they can develop strong commitment to use of the new ideas when there are clear, observable benefits to their students (Crandall 1983, Guskey 1986). Here, teacher involvement in tailoring a new practice to their own

Source: Continuing to Learn: A Guidebook for Teacher Development by Susan Loucks-Horsley et al. Andover, MA: The Regional Laboratory for Educational Improvement of the Northeast and Islands. ©1987, 11-12.

APPROPRIATE PARTICIPANT INVOLVEMENT IN GOAL SETTING, IMPLEMENTATION, EVALUATION, AND DECISION MAKING
(continued)

situations gives them an opportunity to establish a relevance for themselves and the context in which they work.

Any time professional development opportunities ignore the importance of involvement by participants, one can expect only hit-or-miss results.

TIME TO WORK ON PROFESSIONAL DEVELOPMENT AND ASSIMILATE NEW LEARNINGS

Time is both a necessity and a limitation to teacher development. As we have said, learning to teach continues throughout a person's career and requires constant analysis, reflection, experimentation, and support from colleagues. Unfortunately, most school schedules and calendars do not leave time for individual or collective reflection. Without such time, schools cannot encourage investigation or disciplined inquiry into teaching. Neither do they reward those exemplary few who research, write, coach, or collaborate.

Good professional development programs support the necessity of reflective teaching, believing that teachers will be more professional if they keep striving to know their craft better. Doctors and lawyers are expected to stay current and learn new ways of approaching problems; likewise teachers should be supported in their expansion of knowledge and skill. If we want teachers to impart children with powers to think and evaluate information, we must sanction the same inquiry on their part.

If teachers are not engaged in learning, then the price we pay for their limited knowledge is higher than most people realize. It takes time to learn – time to watch, practice, commit to changes, and work them smoothly into one's routine. Time buys new organizational arrangements that can support teacher development, such as limiting the difficulty of teaching assignments for new teachers, reducing teaching loads of advising teachers, hiring more staff or teaming the staff available to cover the classes of teachers released from teaching, and allocating more time for professional development during the school year or beyond the current ten-month year. "Finding more time for teacher growth obviously involves increased costs, but time-efficient [professional] development efforts that do not produce teacher learning are clearly not cost-effective" (Wildman and Niles 1987, 2).

Another issue related to time is the need for stability and continuity to be built into a professional development program. Constant introduction of new programs, change for the sake of change, instability in goals, staff, or funding – all of these are apt to create a climate in which new ideas come and go, nothing takes root, and teachers experience continual frustration. A professional development program balances the infusion of the new with time to effectively implement approaches that have already been introduced.

Source: Continuing to Learn: A Guidebook for Teacher Development by Susan Loucks-Horsley et al. Andover, MA: The Regional Laboratory for Educational Improvement of the Northeast and Islands. ©1987, 12-13.

LEADERSHIP AND SUSTAINED ADMINISTRATIVE SUPPORT

Leadership and support from key school leaders, usually administrators, is critical to the success of professional development efforts (Loucks-Horsley and Hergert 1985). Traditional leaders such as superintendents and principals have an important role in legitimizing and maintaining these efforts. They can choose to orchestrate and direct professional development themselves or delegate leadership to curriculum supervisors, department heads, team leaders, or professional development teams.

When administrators delegate operational functions of professional development to teams or supervisors, they still can support professional development by promoting the activities, focusing the work, helping with the selection of players, providing time and resources, and incorporating the results of professional development into teacher and school evaluation. Beyond these indirect support strategies, administrators can show they value professional development by participating in meetings and helping to select training activities. They can show moral support by verbal praise and encouragement, publication of teacher accomplishments, and providing refreshments at planning meetings.

It is important to note that new leaders emerge from improvement activities. Those who gain a new perspective on teaching can become vital players in the school improvement game. They may assume leadership roles in training others in new techniques or assisting a peer in adapting a strategy; or they may help a superintendent explain a program change to the community or school board. The roles of instructional leadership are not exclusive, and the more people in the education community who can take on leadership roles, the more likely their sense of commitment and responsibility will lead to real school improvement.

Source: *Continuing to Learn: A Guidebook for Teacher Development* by Susan Loucks-Horsley et al. Andover, MA: The Regional Laboratory for Educational Improvement of the Northeast and Islands. ©1987, 13.

APPROPRIATE INCENTIVES AND REWARDS

People can be rewarded in many different ways. Good professional development systems pay attention to incentives and rewards; they have formal reward structures in place, with options and opportunities available so that an individual can decide what is rewarding. Extrinsic rewards such as pay increases or working in a nice facility count with teachers, but intrinsic rewards count more. Teachers are motivated by opportunities to meet new people, share ideas and work together, increase knowledge and competence, and take time to think, talk, and figure out alternative teaching strategies.

Mastery of a new skill is a strong reward as well as a motivator for continuing to use and refine a new approach. Doing something new well can greatly increase teachers' commitment to new approaches, whether or not they were committed when the new approach was first introduced (Crandall 1983).

All of these rewards assume *recognition*, *respect*, and *reinforcement* – the three Rs of job satisfaction that are particularly important incentives for teachers (Jacullo-Noto 1986). If problems such as inconvenient times and locations and forced participation are avoided, such extrinsic incentives as money, credit, or materials, while certainly appreciated, are not necessary for teacher involvement in and commitment to improvement activities. Professional growth is itself a reward. And probably the most powerful motivator is simply a sense of efficacy – a belief that what one does makes a difference (Berman and McLaughlin 1978).

Source: *Continuing to Learn: A Guidebook for Teacher Development* by Susan Loucks-Horsley et al. Andover, MA: The Regional Laboratory for Educational Improvement of the Northeast and Islands. ©1987, 13-14.

APPLICATION OF KNOWLEDGE ABOUT ADULT LEARNING AND THE CHANGE PROCESS

Solid professional development programs take into account what is known about adult learning. They acknowledge that adults learn differently than children. Thus, an understanding of *andragogy*, the teaching of adults, is needed.

Studies of adult development (Krupp 1981, Oja 1980) and of how adults learn best indicate several conditions necessary for adult growth. These include:

- opportunities to try out new practices;
- careful and continuous guided reflection and discussion about the proposed changes;
- continuity of programs and time for significant change; and
- personal support as well as challenge during this change process (Sprinthall and Sprinthall 1983).

Training designs that reflect these conditions include the following:

- study of the theory or rationale for the desired teaching method or change;
- observation of demonstrations of the practice;
- discussion of application;
- practice and feedback; and
- coaching for application in the work setting (Joyce and Showers 1982, Sparks 1983).

If most professional development programs aim to change the behavior of teachers, as we believe they do, then attention to what is known about the change process can also make professional development more successful. A useful frame of reference is provided by the Concerns-Based Adoption Model (CBAM), which describes how individuals develop in their feelings and skills as they are introduced to and implement something new. When professional developers know "where people are" in the change process, they can tailor their help and support to teachers' developmental levels (Hall and Loucks 1978).

Source: Continuing to Learn: A Guidebook for Teacher Development by Susan Loucks-Horsley et al. Andover, MA: The Regional Laboratory for Educational Improvement of the Northeast and Islands. ©1987, 14-15.

APPLICATION OF KNOWLEDGE ABOUT ADULT LEARNING AND THE CHANGE PROCESS (continued)

For example, when teachers (and others) engage in a new practice, their concerns about the practice change, as does their skill in using it. When first considering a change, the most dominant concerns are self-oriented – "What is it, and how will it affect me?" Later, concerns change to wanting to master the new practice, to getting coordinated and organized to use it comfortably. Finally, when the practice has been mastered, concerns are focused more on how it is affecting students and how it can be changed to have greater impact.

Good planners keep the notion of changing concerns in mind as they design professional development activities. They make sure teachers have the opportunity to resolve their concerns as they emerge, providing answers to the questions teachers are asking when they are most salient. For example, early in the process teachers are more likely to want to know what a new practice will look like in their classrooms and what the expectations of administrators are, rather than wanting focused training in how-to-do-it or in evaluating student outcomes. A common mistake of professional developers is to design activities related to *their* concerns, rather than the concerns of teachers, and their concerns are often quite different.

If change is a process, then another application of change process research is providing sufficient time, attention, and assistance for new ideas and skills to take hold. Hunter (1985) has aptly labelled as "creative floundering" the unstable period of trial and error during which participants in professional development are practicing, receiving feedback, adjusting, and practicing again. Getting through this period successfully requires considerable time. As Loucks-Horsley and Hergert (1985) observe, implementing and mastering any new practice requires more than a one or two day "hit and run" workshop and a cheerful, "God bless you." Learning and applying new concepts and skills do not occur overnight. One-time training sessions – regardless of the length – are rarely sufficient.

Professional development is most influential when it is conducted often enough and long enough to ensure progressive gains in knowledge, skill, and confidence (Little 1986). If, as Crandall (1983) and Guskey (1986) claim, change in teacher attitudes and beliefs occurs *after* teachers have had a chance to practice strategies with their students and see the results, then follow-up after training is even more crucial than the training activity itself. Such support over time builds the commitment, shared understanding, and collegiality characteristic of successful professional development efforts.

INTEGRATION OF INDIVIDUAL GOALS WITH SCHOOL AND DISTRICT GOALS

A good professional development program is like an umbrella: it takes into account all that is under its protection. It considers the goals of individual teachers as well as those of the school and the district, and it works hard to integrate these into a whole.

Demands on schools and teachers come in many forms and from many places. Responding to these can be piecemeal or planned. In places where professional development works to support growth and development, the needs stimulated by these demands are incorporated into an overall plan. As with all professionals, when it comes to their own development, teachers have both privileges and responsibilities. They can choose ways of satisfying their growth needs, as well as participate in activities to further the improvement of their school and district. A good professional development program maximizes the extent to which these two are integrated and the extent to which teachers have influence over their integration.

Source: *Continuing to Learn: A Guidebook for Teacher Development* by Susan Loucks-Horsley et al. Andover, MA: The Regional Laboratory for Educational Improvement of the Northeast and Islands. ©1987, 16.

407

FORMAL PLACEMENT OF THE PROGRAM WITHIN THE PHILOSOPHY AND ORGANIZATIONAL STRUCTURE OF THE SCHOOL AND DISTRICT

Formal establishment of defined mechanisms that promote professional development, such as district-level inservice coordinating committees and school-based planning teams, protects collaborative planning and increases the likelihood that improvement activities will continue over time. In districts or schools that do not develop such structures, planning and management of improvement are dependent upon a few energetic individuals; they often cease altogether if those individuals move on to other things or districts. Different activities and strategies come and go, with no glue to hold them together and ensure continuity. Only if professional development is embedded in the philosophy and organizational structure of schools and districts can a culture of continuous growth thrive.

Source: *Continuing to Learn: A Guidebook for Teacher Development* by Susan Loucks-Horsley et al. Andover, MA: The Regional Laboratory for Educational Improvement of the Northeast and Islands. ©1987, 17.

INVENTORY: CHARACTERISTICS OF EFFECTIVE PROFESSIONAL DEVELOPMENT PROGRAMS

PART I

How does your science and mathematics professional development program rate on these characteristics?

		⇐ nonexistent/clearly evident ⇒
1.	Collegiality and collaboration	1 2 3 4 5
2.	Experimentation and risk taking	1 2 3 4 5
3.	Use of available knowledge bases	1 2 3 4 5
4.	Participant involvement in appropriate aspects	1 2 3 4 5
5.	Time to participate and practice	1 2 3 4 5
6.	Leadership and sustained support	1 2 3 4 5
7.	Appropriate incentives and rewards	1 2 3 4 5
8.	Application of knowledge about adult learning and change	1 2 3 4 5
9.	Integration of individual, school, and district goals	1 2 3 4 5
10.	Integration of science and mathematics professional development with other professional development and organizational development activities	1 2 3 4 5

PART II

1. Identify the three attributes that pose the greatest challenge for you.

2. What are some ways you might address these challenges?

Source: *Building Systems for Professional Growth: An Action Guide* by Margaret A. Arbuckle and Lynn B. Murray. Andover, MA: The Regional Laboratory for Educational Improvement of the Northeast and Islands. ©1989, 2-49.

REFLECT AND WRITE

1. Professional development's success will be judged primarily not only by how many teachers and administrators participate in professional development programs or how they perceive its value, but by whether it alters instructional behavior in a way that benefits students.

2. Constructivist teaching will be best learned through constructivist professional development. Rather than receiving "knowledge" from "experts" in training sessions, teachers and administrators will collaborate with peers, researchers, and their own students to make sense of the teaching/learning process in their own contexts.

3. An important lesson from the past few years, however, has been that improvements in individual performance alone are insufficient to produce the results we desire. It is now clear that success for all students depends upon both the learning of individual school employees *and* improvements in the capacity of the organization to solve problems and renew itself.

4. Professional developers are more frequently called on today to facilitate meetings or to assist various work groups (e.g., a school faculty, the superintendent's cabinet, a school improvement team) to solve problems or develop long-range plans.

Source: Reprinted with permission of *Education Week* from "A Paradigm Shift in Staff Development" by Dennis Sparks. ©1994, 42.

SHIFTING THE PARADIGM OF PROFESSIONAL DEVELOPMENT

From Too Much	**To More**
Focus on teacher needs	Focus on student learning outcomes
Focus on individual development	Focus on individual and system development
Transmission of knowledge, skills, and strategies	Inquiry into teaching and learning
"Pull-out" training	Job-embedded learning
Generic teaching skills	Combination of content and content-specific teaching skills
Fragmented, piecemeal, one-shot	Driven by clear, coherent, long-term strategic plan
District direction and decision making	School direction and decision making
Professional developers as trainers	Professional developers as facilitators, consultants, planners
Professional development as some people's jobs	Professional development as everyone's job
Professional development for teachers	Professional development for everyone
Professional development as a "frill"	Professional development as essential

Source: Adapted with permission of the authors from "Shifting the Paradigm of Professional Development" by Susan Loucks-Horsley and Dennis Sparks. Developed for the Goals 2000 Conference, Washington, DC, May 1994.

A PARADIGM SHIFT IN STAFF DEVELOPMENT

During the past 20 years it has gone by many names – in-service education, staff development, professional development, and human resource development. But whatever it was called, it too often was essentially the same thing – educators (usually teachers) sitting relatively passively while an "expert" "exposed" them to new ideas or "trained" them in new practices. The success of this endeavor was typically judged by a "happiness quotient" that measured participants' satisfaction with the experience and their assessment regarding its usefulness in their work.

Fortunately, all of this is at long last being swept away by irresistible forces that are currently at work in education. History teaches us the power of a transforming idea, an alteration in world view so profound that all that follows is changed forever. Such a paradigm shift is now rapidly transforming the discipline of "staff development." (I will use this term throughout because our professional language has not yet caught up with the paradigm shift that is described below.)

Three powerful ideas are currently altering the shape of this nation's schools and the "staff development" that occurs within them. The first is the notion of results-driven education which judges success not by the courses students take or the grades they receive, but by what they actually know and can do as a result of their time in school. Results-driven education will require that teachers and administrators alter their attitudes (e.g., from grades should be based on the bell curve to the belief that virtually all students can acquire the school's valued outcomes provided they are given sufficient time and appropriate instruction) and acquire new instructional knowledge and skills.

Results-driven education for students will require results-driven staff development for educators. Staff development's success will be judged primarily not by how many teachers and administrators participate in staff development programs or how they perceive its value, but by whether it alters instructional behavior in a way that benefits students. The goal of staff development and other improvement efforts is becoming improved performance – improved performance on the part of students, staff, and the organization.

The second transforming idea is that of systems thinking, which recognizes the complex, interdependent interrelationships among the various parts of the system. When the parts of a system come together they form something that is bigger and more complex than those individual parts. "Systems thinkers" are individuals who are able to see how these parts constantly influence one another in ways which can support or hinder improvement efforts. Because educational leaders typically have not thought systemically, reform has been approached in a piecemeal fashion.

Source: Reprinted with permission of *Education Week* from "A Paradigm Shift in Staff Development" by Dennis Sparks. ©1994, 42.

An important aspect of systems thinking is that changes in one part of the system – even relatively minor changes – can have significant effects on the other parts of the system, either positively or negatively. To complicate the situation, these effects may not become obvious for months or even years, which may lead observers to miss the link between the two events. For instance, graduation requirements may be increased, teachers may be trained in some new process, or decision-making decentralized, with little thought given to how these changes influence other parts of the system. As a result, "improvements" in one area may produce unintended consequences in another part of the system (e.g., increasing graduation requirements in science without appropriate changes in assessment, curriculum, and instructional methods may increase the dropout rate).

To address this issue, Peter Senge, author of *The Fifth Discipline*, encourages organizational leaders to identify points of high leverage in the system – points that he refers to as "trim tabs." Change introduced into these areas can have a positive ripple effect throughout the organization (e.g., a change in assessment strategies may have a significant effect on curriculum and instruction).

The third powerful idea is constructivism. Constructivists believe that learners build knowledge structures rather than merely receive them from teachers. In this view knowledge is not simply transmitted from teacher to student, but instead constructed in the mind of the learner. From a constructivist perspective it is critical that teachers model appropriate behavior, guide student activities, and provide various forms of examples rather than use common instructional practices that emphasize telling and directing.

Constructivist teaching will be best learned through constructivist staff development. Rather than receiving "knowledge" from "experts" in training sessions, teachers and administrators will collaborate with peers, researchers, and their own students to make sense of the teaching/learning process in their own contexts. Staff development from a constructivist perspective will include activities such as action research, conversations with peers about the beliefs and assumptions that guide their instruction, and reflective practices like journal keeping – activities which many educators may not even view as staff development.

Results-driven education, systems thinking, and constructivism are producing profound changes in how staff development is conceived and implemented. Some of the most important of these changes are:

- *From individual development to individual development and organization development.* Too often we have expected dramatic changes in schools based solely on staff development programs intended to help individual teachers and administrators do their jobs more effectively. An important lesson from the past few years, however, has been that improvements in individual performance alone are insufficient to produce the results we desire.

  It is now clear that success for all students depends upon both the learning of individual school employees *and* improvements in the capacity of the organization to solve problems and renew itself. While the knowledge, skills, and attitudes of individuals must continually be addressed, quality improvement expert W. Edwards Deming estimates that 85% of the barriers to improvement reside in the organization's structure and processes, not in the performance of individuals. For instance, asking teachers to hold higher expectations for students within a school that tracks students pits teachers against the system in which they work. As systems thinking has taught us, unless individual learning and organizational changes are addressed simultaneously and support one another, the gains made in one area may be canceled by continuing problems in the other.

- *From fragmented, piecemeal improvement efforts to staff development driven by a clear, coherent strategic plan for the school district, each school, and for the departments that serve schools.* Educational experts such as Seymour Sarason and Michael Fullan have criticized schools for their fragmented approach to change. School improvement too often has been based on fad rather than a clear, compelling vision of the school system's future. This, in turn, has led to one-shot staff development workshops with no thought given to follow-up nor how this technique fits in with those that were taught in previous years. At its worst, teachers are asked to implement poorly understood innovations with little support and assistance, and before they are able to approach mastery, the school has moved on to another area.

  An orientation to outcomes and systems thinking has led to strategic planning at the district, school, and department levels. Clear, compelling mission statements and measurable objectives expressed in terms of student outcomes give guidance to the type of staff development activities that would best serve district and school goals. In turn, district offices such as staff development and curriculum see themselves as service agencies for schools. This comprehensive approach to change makes certain that all aspects of the system (e.g., assessment, curriculum, instruction, parent involvement) are working in tandem toward a management set of outcomes that are valued throughout the system.

- *From district-focused to school-focused approaches to staff development.* While districtwide awareness and skill building programs sometimes have their place, more attention today is being directed at helping schools meet their improvement goals. Schools set their goals both to assist the school system in achieving its long-term objectives and to address challenges unique to their students' needs.

  School improvement efforts in which the entire staff seeks incremental annual improvement related to a set of common objectives (e.g., helping all students become better problem solvers, increasing the number of students who participate in a voluntary community service program to 100%) over a three to five year span are viewed as the key to significant reform. As a result, more learning activities are designed and implemented by school faculties, with the district's staff development department providing technical assistance and functioning as a service center to support the work of the schools.

- *From training that one attends away from the job as the primary delivery system for staff development to multiple forms of job-embedded learning.* Critics have long argued that too much of what passes as staff development is "sit and get" in which educators are passive recipients of received wisdom. Likewise, a great deal of staff development could be thought of as "go and get" because "learning" has typically meant leaving the job to attend to a workshop or other event.

  While well-designed training programs followed by coaching will continue to be the preferred method for the development of certain skills, school employees will also learn through such diverse means as action research, participating in student groups or small-group problem solving, observing peers, journal writing, and through involvement in improvement processes (e.g., participation in curriculum development, school improvement planning).

- *From staff developers who function primarily as trainers to those who provide consultation, planning, and facilitation services, as well as training.* Staff developers are more frequently called on today to facilitate meetings or to assist various work groups (e.g., a school faculty, the superintendent's cabinet, a school improvement team) solve problems or develop long-range plans. While staff developers will continue to provide training in instructional areas, results-driven education and systems thinking have placed teachers, administrators, and school employees in new roles (e.g., team leader, strategic planning team member) for which training in areas such as conducting effective meetings is required for their successful performance.

- *From staff development provided by one or two departments to staff development as a critical function and major responsibility performed by all administrators and teacher leaders.* Job-embedded staff development means that superintendents, assistant superintendents, curriculum supervisors, principals, and teacher leaders, among others, must see themselves as teachers of adults and view the development of others as one of their most important responsibilities. Individuals who perform these roles are increasingly being held accountable for their performance as planners and implementors of various forms of staff development.

  As responsibility for staff development has been spread throughout the school system, the role of the staff development department has become even more important. Staff development departments are assisting teachers and administrators by offering training and ongoing support in acquiring the necessary knowledge and skills to assume their new responsibilities, by providing one-to-one coaching of these individuals in their new roles, and by facilitating meetings that are best led by individuals who are outside that particular group, among other responsibilities.

- *From teachers as the primary recipients of staff development to continuous improvement in performance for everyone who affects student learning.* To meet the educational challenges of the 21st Century, everyone who affects student learning must continually upgrade his or her skills – school board trustees, superintendents, and other central office administrators, principals, teachers, the various categories of support staff (e.g., aides, secretaries, bus drivers, custodians), and parents and community members who serve on policy-making boards and planning committees.

- *From staff development as a "frill" that can be cut during difficult financial times to staff development as an essential and indispensable process without which schools cannot hope to prepare young people for citizenship and productive employment.* Both the development of school employees and significant changes in the organizations in which they work are required if schools are to adequately prepare students for life in a world that is becoming increasingly more complex. Fortunately, results-driven education and systems thinking provide us with the intellectual understanding and the means to create the necessary reforms.

The shifts described above are significant and powerful. They are essential to the creation of learning communities in which everyone – students, teachers, principals, and support staff – are both learners and teachers. All of the things described above will serve to unleash the most powerful source of success for all students, young people who are in the daily presence of adults who are passionately committed to their own life-long learning within organizations that are continually renewing themselves.

10

ALTERNATIVE MODELS OF PROFESSIONAL DEVELOPMENT

Audience:

- Individuals responsible for planning and implementing professional development for science and mathematics educators at the building, district, regional, or state level.

Desired Outcomes for Participants:

- To identify the benefits, key features, and implementation requirements for six models of professional development.
- To determine possible applications for these models in participants' professional development programs.

Materials:

- **Transparencies:**
  - *Alternative Models of Professional Development* (10-5)
  - *Flow of Jigsaw* (10-6)
- **Handouts:**
  - *Group Task for Expert Groups* (10-7)
  - *Discussion Questions for Home Groups* (10-8)
  - *Shifting the Paradigm of Professional Development* (9-44)
- **Readings:**
  - "Five Models of Staff Development for Teachers" by Dennis Sparks and Susan Loucks-Horsley. *Journal of Staff Development*, Fall 1989, 10 (4): 40-57.
  - "Scaling the Heights: Math Cases Build Learning Communities," *Far West Focus on Changing School Practice* (newsletter of Far West Laboratory), October 1993, 1-4.
  - "The Mathematics Curriculum and Teaching Program: Guidelines for Consultants and Curriculum Leaders" by John Owen, Neville Johnson, Doug Clarke, Charles Lovitt, and Will Morony. Victoria, Australia: Curriculum Corporation, 1988, selected excerpts.
- Overhead projector and screen
- Newsprint, easel, markers, blank paper, and pens or pencils

Time Required: Three hours

Facilitator's Notes: Typically, educators think of professional development as inservice workshops or institutes. This activity provides a prime opportunity to expose participants to several alternatives. Encourage sharing of examples from participants' own experiences of the models included in this activity, as well as additional models that participants have used, observed, read, or heard about.

Process:

1. Explain that while there are many ways and formats for learning, educators have traditionally relied on one: the inservice workshop. Ask participants to turn to someone next to them and share other ways they have engaged in professional learning. Ask for a few examples back in the large group.

2. Tell participants that in this activity they will explore six models of professional development and look at how they might be implemented in their setting. Explain that a jigsaw process will be used.

3. Using the **Alternative Models of Professional Development (10-5)** transparency, briefly describe the six models. The first five models are described in the "Five Models of Staff Development" article and the sixth model is discussed in the "Scaling the Heights: Math Cases Build Learning Communities" article (both enclosed in this activity).

   Note: Because even these six general models do not contain *all* possible formats for professional development, we have added an "other" category which participants may want to explore now or in the future.

4. Have participants form home groups of six. (District, school, or state-based teams are ideal.) Using the **Flow of Jigsaw (10-6)** transparency, explain the process. (For more information on the jigsaw technique, see **Appendix B-3**.)

   As individual home group members select their model to become expert in, hand out one copy of each reading to each person. Explain where in the articles the six models are described and tell them they will only need to read that section of the article.

If a member of a group wants to explore the "other" category, they may find the article "The Mathematics Curriculum and Teaching Program: Guidelines for Consultants and Curriculum Leaders" helpful. (Individuals who choose the "other" category will need to be proactive in finding expert groupmates.)

5. Instruct all participants to assemble into expert groups. It may be helpful to set up table-tent signs with each of the six models so expert groups can easily convene. Expert groups should have no more than four to six people. Depending on the size of the home groups, expert teams may need to break up into two or more groups.

   Distribute the handout **Group Task for Expert Groups (10-7)** and tell participants they will have 40 minutes to read their section of the article and prepare a presentation of the model.

6. Each expert group then has about five minutes to present to the whole group.

7. Reassemble into home groups. Distribute the handout **Discussion Questions for Home Groups (10-8)** and allow 20 minutes to discuss.

8. Each home group reports out their insights – list them together on newsprint. Then each group shares one burning question and others in the larger group suggest answers. Ask for their ideas about the relationship to systemic change (discussion question #3).

9. Ask each person to jot down some ideas to complete the stem:

   "I intend to explore the ____________ model further because ____________________________."

   Ask them to share briefly with a partner. Ask for a few to share with the large group.

10. Ask participants to relate the six models to the handout **Shifting the Paradigm of Professional Development (9-44)** from **Activity 9: What Is Good Professional Development?** Have them dialogue about the following questions:

    - In what ways do the alternative models support the shift?
    - Do some models seem more "systemic" than others?
    - Might some work better at some times or in some parts of the change process than others?

Additional References: Loucks-Horsley, Susan; Catherine Harding; Margaret A. Arbuckle; Lynn B. Murray; Cynthia Dubea; and Martha K. Williams. 1987. "Alternative Approaches to Teacher Development," Chapter 4 in *Continuing to Learn: A Guidebook for Teacher Development*. Andover, MA: The Regional Laboratory for Educational Improvement of the Northeast and Islands.

ALTERNATIVE MODELS OF PROFESSIONAL DEVELOPMENT

- Individually guided professional development
- Observation/assessment
- Involvement in a development/ improvement process
- Training
- Inquiry
- Case development
- Other

FLOW OF JIGSAW

1. Assemble in home groups of six.
2. Each member chooses a model.
3. Assemble in expert groups of four to six.
4. Read introduction and section about your model (20 minutes).
5. Discuss and create your group presentation (20 minutes).
6. Expert groups present to large group.
7. Reassemble in home groups.
8. Discuss the home group questions (20 minutes).
9. Report out.

GROUP TASK FOR EXPERT GROUPS

Your group will make a *creative* presentation of this model to the whole group. It may be a skit, a poem, a rap, a graphic, etc.

In your presentation, be sure to cover the following:

- purpose of the model,
- expected outcomes of the model,
- requirements for implementing the model, and
- advantages and disadvantages of the model for science and mathematics improvement.

DISCUSSION QUESTIONS
FOR HOME GROUPS

1. When would you choose to use each model? (e.g., for what outcomes? With what resource constraints? With what kinds of schools, teachers, administrators?)

2. How could you use one or more of these models in your current situation?

3. How does consideration of these models contribute to systemic change in science and mathematics?

4. Report out one or two insights and one or two "burning questions" to ask the whole group.

Reprinted with permission of the
National Staff Development Council.
(c) 1989, 40-57.

Five Models of Staff Development for Teachers

This article organizes what is known about effective staff development into five models currently being espoused and used by staff developers. A review of the supporting theory and research on these models is followed by a description of what is currently known about the organizational context that is required to support successful staff development efforts.

DENNIS SPARKS
SUSAN LOUCKS-HORSLEY

Dennis Sparks is executive director, National Staff Development Council, 517 North York, Dearborn, Michigan 48128. Susan Loucks-Horsley is program director for teacher development, The Regional Laboratory for Educational Improvement of the Northeast and Islands, 290 South Main Street, Andover, Massachusetts 01810.

In the early 1970s, a growing concern about the effectiveness of inservice education resulted in a spate of studies to determine the attitudes of educators about these programs (Ainsworth, 1976; Brim & Tollett, 1974; Joyce & Peck, 1977; Zigarmi, Betz, & Jensen, 1977). The findings indicated nearly unanimous dissatisfaction with current efforts, but a strong consensus that inservice was critical if school programs and practices were to be improved (Wood & Kleine, 1987).

During the late 1970s and early 1980s, several major studies and reviews contributed to our understanding of the characteristics of effective staff development, focusing not on attitudes, but on actual practices (Berman & McLaughlin, 1978; Kells, 1980; Lawrence, 1974; Yarger, Howey, & Joyce, 1980). The resulting list of effective practices, well known by now, included:

- Programs conducted in school settings and linked to school-wide efforts
- Teachers participating as helpers to each other and as planners, with administrators, of inservice activities
- Emphasis on self instruction, with differentiated training opportunities
- Teachers in active roles, choosing goals and activities for themselves
- Emphasis on demonstration, supervised trials, and feedback; training that is concrete and ongoing over time
- Ongoing assistance and support available on request

Staff development came of age in the 1980s. It was the focus of countless conferences, workshops, articles, books, and research reports. State legislators and administrators of local school districts saw staff development as a key aspect of school improvement efforts. Many school districts initiated extensive staff development projects to improve student learning. Research on these projects and craft knowledge generated by staff developers have substantially advanced our understanding of effective staff development practices beyond the overview studies of the early 1980s referred to above.

Introduction

In spite of this recent intense, widespread interest in staff development, much remains to be learned about the process. This article organizes what is known about effective staff development into five models currently being espoused and used by staff developers. A review of the supporting theory and research on these models is followed by a description of what is currently known about the organizational context that is required to support successful staff development efforts. The conclusion discusses what can be said with confidence about effective staff development practice and what remains to be learned. First, however, are definitions of the key terms and a description of the literature that is used throughout the article.

Definitions

Staff development is defined as those processes that improve the job-related knowledge, skills, or attitudes of school employees. While participants in staff development activities may include school board members, central office administrators, principals, and non-certified staff, this article focuses on staff development for teachers. In particular, it examines what is known about staff development that is intended to improve student learning through enhanced teacher performance.

Two uses of the word "model" have been combined in an effort to both conceptualize staff development and make this conceptualization useful to staff developers. First, borrowing from Ingvarson's (1987) use of the term, a model can be seen as a design for learning which embodies a set of assumptions about (a) where knowledge about teaching practice comes from, and (b) how teachers acquire or extend their knowledge. Models chosen for discussion differ in their assumptions. Second, adapting Joyce and Weil's (1972) definition of a model of teaching, a staff development model is a pattern or plan which can be used to guide the design of a staff development program.

Each staff development model presented below is discussed in terms of its theoretical and research underpinnings, its critical attributes (including its underlying assumptions and phases of activities), and illustrations of its impact on teacher growth and development. The literature supporting these models is of several types. First, for each model, the theoretical and research bases that support its use in improving teachers' knowledge, skills, or attitudes are considered. The question asked was: Why should one believe that this model *should* affect teachers' classroom behavior? Second, program descriptions were reviewed in which these models were applied. The question asked was: What evidence exists that demonstrates that this model can be implemented by staff developers in schools and school districts? Third, data about outcomes was sought. The question asked was: What evidence indicates that this model actually makes a difference in teacher performance?

An Overview

This article presents five models of staff development: (a) individually-guided staff development, (b) observation/assessment, (c) involvement in a development/improvement process, (d) training, and (e) inquiry.

Individually-guided staff development refers to a process through which teachers plan for and pursue activities they believe will promote their own learning. The observation/assessment model provides teachers with objective data and feedback regarding their classroom performance. This process may in itself produce growth or it can provide information that may be used to select areas for growth.

Involvement in a development/improvement process engages teachers in developing curriculum, designing programs, or engaging in a school improvement process to solve general or particular problems. The inquiry model requires that teachers identify an area of instructional interest, collect data, and make changes in their instruction based on an interpretation of those data. The training model (which may be synonymous with staff development in the minds of many educators) involves teachers in acquiring knowledge or skills through appropriate individual or group instruction.

Next, this article examines the organizational context that is required to support these models. Our discussion includes organizational climate, leadership and support, district policies and systems, and participant involvement.

The final section looks for gaps in the knowledge base of staff development, identifying areas about which there is still more to learn and areas that as yet remain unexplored by researchers. The hope is that this article and the chapter from which it is adapted will serve as both a signpost for how far we have come in the past 20 years in our understanding of effective staff development practices and a springboard for future research in this vital area.

Staff development came of age in the 1980s. It was the focus of countless conferences, workshops, articles, books, and research reports. State legislators and administrators of local school districts saw staff development as a key aspect of school improvement efforts. Many school districts initiated extensive staff development projects to improve student learning.

Five Models of Staff Development

1. Individually-Guided Staff Development

Teachers learn many things on their own. They read professional publications, have discussions with colleagues, and experiment with new instructional strategies, among other activities. All of these may occur with or without the existence of a formal staff development program.

It is possible, however, for staff development programs to actively promote individually-guided activities. While the actual activities may vary widely, the key characteristic of the individually-guided staff development model is that the learning is designed by the teacher. The teacher determines his or her own goals and selects the activities that will result in the achievement of those goals. Perhaps a sense of this model is best represented in an advertisement for the Great Books Foundation which reads: "At 30, 50, or 70, you are more self-educable than you were at 20. It's time to join a Great Books reading and discussion group."

Underlying assumptions. This model assumes that individuals can best judge their own learning needs and that they are capable of self direction and self-initiated learning. It also assumes that adults learn most efficiently when they initiate and plan their learning activities rather than spending their time in activities that are less relevant than those they would design. (It is, however, true that when individual teachers design their own learning there is much "reinventing of the wheel," which may seem inefficient to some observers.) The model also holds that individuals will be most motivated when they select their own learning goals based on their personal assessment of their needs.

Theoretical and research underpinnings. According to Lawrence's (1974) review of 97 studies of inservice programs, programs with individualized activities were more likely to achieve their objectives than were those that provided identical experiences for all participants. Theory supporting the individually-guided model can be found in the work of a number of individuals. Rogers' (1969) client-centered therapy and views on education are based on the premise that human beings will seek growth given the appropriate conditions. "I have come to feel," Rogers wrote, "that the only learning which significantly influences behavior is self-discovered, self-appropriated learning" (p. 153).

The differences in people and their needs are well represented in the literature on adult learning theory, adult development, learning styles, and the change process. Adult learning theorists (Kidd, 1973; Knowles, 1980) believe that adults become increasingly self-directed and that their readiness to learn is stimulated by real life tasks and problems. Stage theorists (Levine, 1989) hold that individuals in different stages of development have different personal and professional needs. Consequently, staff development that provides practical classroom management assistance to a 22-year-old beginning teacher may be inappropriate for a teaching veteran who is approaching retirement.

Learning styles researchers (Dunn & Dunn, 1978; Gregorc, 1979) argue that individuals are different in the ways they perceive and process information and in the manner in which they most effectively learn (e.g., alone or with others, by doing as opposed to hearing about). Research on the Concerns-Based Adoption Model (CBAM) (Hall & Loucks, 1978) indicates that as individuals learn new behaviors and change their practice, they experience different types of concerns that require different types of responses from staff developers. For instance, when first learning about a new instructional technique, some teachers with personal concerns require reassurance that they will not be immediately evaluated on the use of the strategy, while a teacher with management concerns wants to know how this technique can be used in the classroom.

Taken together, these theorists and researchers recognize that the circumstances most suitable for one person's professional development may be quite different from those that promote another individual's growth. Consequently, individually-guided staff development allows teachers to find answers to self-selected professional problems using their preferred modes of learning.

Phases of activity. Individually-guided staff development consists of several phases: (a) the identification of a need or interest, (b) the development of a plan to meet the need or interest, (c) the learning activity(ies), and (d) assessment of whether the learning meets the identified need or interest. These phases might be undertaken informally and almost unconsciously, or they may be part of a formal, structured process. Each phase is explained in greater detail below.

With the identification of a need or interest, the teacher considers what he or she needs to learn. This assessment may be done formally (e.g., the completion of a needs assessment process or as a result of evaluation by a supervisor) or occur more spontaneously (e.g., a conversation with a colleague or reflection upon an instructional problem). The need or interest may be remedial (e.g., "I've really come to dislike my work because of the classroom management problems I'm having") or growth-oriented (e.g., "I'm intrigued by recent research on the brain and want to better understand its implications for student learning").

Having identified the need or interest, the teacher selects a learning objective and chooses activities that will lead to accomplishing this objective. Activities may include workshop attendance, reading, visits to another classroom or school, or initiation of a seminar or similar learning program.

The learning activity may be single session (e.g., attendance at a workshop on new approaches to reading in the content areas) or occur over time (e.g., examination of the research on retaining students in grade). Based on the individual's preferred mode of learning, it may be done alone (e.g., reading or writing), with others (e.g., a seminar that considers ways of boosting the self-esteem of high school students), or as a combination of these activities.

When assessing formal individually-guided processes the teacher may be asked to make a brief written report to the funding source or an oral report to colleagues. In other instances the teacher may simply be aware that he or she now better understands something. It is not uncommon that as a result of this assessment phase the teacher may realize how much more there is to be learned on the topic or be led to a newly emerging need or interest.

Illustrations and outcomes. Individually-guided staff development may take many forms. It may be as simple as a teacher reading a journal article on a topic of interest. Other forms of individually-guided staff development are more complex. For instance, teachers may design and carry out special professional projects supported by incentive grants such as a competitive "teacher excellence fund" promoted by Boyer (1983) or "mini-grants" described by Mosher (1981). Their projects may involve research, curriculum development, or other learning activities. While evidence of outcomes for such programs is not substantial, there are indications that they can empower teachers to address their own problems, create a sense of professionalism, and provide intellectual stimulation (Loucks-Horsley, Harding, Arbuckle, Dubea, Murray, & Williams, 1987). This strategy proved effective in New York City and Houston, where teachers were supported to develop and disseminate their own exemplary programs through Impact II grants. They reported changes in their classroom practices, as well as increases in student attendance, discipline, and motivation (Mann, 1984-85).

Teacher evaluation and supervision can be a source of data for individually guided staff development. McGreal (1983) advocates that goal setting be the principal activity of teacher evaluation. Supervisors would assist in the establishment of those goals based on the motivation and ability of the teacher. The type of goals, the activities teachers engage in to meet the goals, and the amount of assistance provided by supervisors would differ from teacher to teacher based upon developmental level, interests, concerns, and instructional problems.

Similarly, Glatthorn's (1984) "differentiated supervision" calls for "self-directed development" as one form of assistance to teachers. Self-directed development is a goal-based approach to professional improvement in which teachers have access to a variety of resources for meeting their collaboratively identified needs.

Research on teacher centers also demonstrates the value of individually guided staff development. Hering and Howey (1982) summarized research conducted on 15 teacher centers sponsored by the Far West Laboratory for Educational Research and Development from 1978 to 1982. They concluded that, "the most important contribution of teachers' centers is their emphasis on working with individual teachers over time" (p. 2). Such a focus on individual teachers is absent from many traditional staff development programs, which teacher centers appear to complement quite effectively.

Hering and Howey (1982) reported that mini-grants of up to $750 provided by the St. Louis Metropolitan Teacher Center were used to fund a variety of classroom-oriented projects. Interviews with participants found that teachers made extensive use of the ideas and products they developed. Some of these projects eventually affected not only an individual classroom, but a school or the entire district. Regarding this project, Hering and Howey concluded:

> *As would be expected, teachers who were given money and support reported high levels of satisfaction and a sense of accomplishment. Also not surprisingly, they developed projects anchored in the realities of the classroom and responsive to the needs and interests of their students. Perhaps most important, however, is the strong suggestion that they can, indeed, influence change and innovation in other classrooms, as well as their own, through projects they design at minimal costs. (p. 6)*

Hering and Howey (1982) also report the findings for a study done on individualized services provided at the Northwest Staff Development Center in Livonia, Michigan. Even though these awards rarely exceeded $50, 78 percent of the recipients reported that they had considerable control over their own learning and professional development. Almost 85 percent of the recipients thought that these services made a substantive difference in their classrooms. In summarizing the value of individualized services, the researchers wrote, "Individual teacher needs and concerns have to be attended to, as well as schoolwide collective ones, or enthusiasm for the collective approach will quickly wane" (p. 6).

While there are many illustrations of an individualized approach to staff development in the literature and many more in practice, research on its impact on teaching is largely perceptual and self-report. Perhaps as more resources are directed to

The circumstances most suitable for one person's professional development may be quite different from those that promote another individual's growth. Consequently, individually-guided staff development allows teachers to find answers to self-selected professional problems using their preferred modes of learning.

supporting this strategy — particularly in the form of incentive grants to teachers — more will be learned about its contribution to teacher, as well as student, growth.

2. **Observation/Assessment**

"Feedback is the breakfast of champions" is the theme of Blanchard and Johnson's (1982) popular management book, *The One Minute Manager*. Yet many teachers receive little or no feedback on their classroom performance. In fact, in some school districts teachers may be observed by a supervisor as little as once every 3 years, and that observation/feedback cycle may be perfunctory in nature.

While observation/assessment can be a powerful staff development model, in the minds of many teachers it is associatedith evaluation. Because this process often has not been perceived as helpful (Wise & Darling-Hammond, 1985), teachers frequently have difficulty understanding the value of this staff development model. However, once they have had an opportunity to learn about the many forms this model can take (for instance, peer coaching and clinical supervision, as well as teacher evaluation), it may become more widely practiced.

Underlying assumptions. One assumption underlying this model, according to Loucks-Horsley and her associates (1987), is that "Reflection and analysis are central means of professional growth" (p. 61). Observation and assessment of instruction provide the teacher with data that can be reflected upon and analyzed for the purpose of improving student learning.

A second assumption is that reflection by an individual on his or her own practice can be enhanced by another's observations. Since teaching is an isolated profession, typically taking place in the presence of no other adults, teachers are not able to benefit from the observations of others. Having "another set of eyes" gives a teacher a different view of how he or she is performing with students.

Another assumption is that observation and assessment of classroom teaching can benefit both involved parties — the teacher being observed and the observer. The teacher benefits by another's view of his or her behavior and by receiving helpful feedback from a colleague. The observer benefits by watching a colleague, preparing the feedback, and discussing the common experience.

A final assumption is that when teachers see positive results from their efforts to change, they are more apt to continue to engage in improvement. Because this model may involve multiple observations and conferences spread over time, it can help teachers see that change is possible. As they apply new strategies, they can see changes both in their own and their students' behavior. In some instances, measurable improvements in student learning will also be observed.

Individual teacher needs and concerns have to be attended to, as well as school-wide collective ones, or enthusiasm for the collective approach will quickly wane.

Theoretical and research underpinnings. Theoretical and research support for the observation/assessment model can be found in the literature on teacher evaluation, clinical supervision, and peer coaching. Each of these approaches is based on the premise that teaching can be objectively observed and analyzed and that improvement can result from feedback on that performance.

McGreal's (1982) work on teacher evaluation suggests a key role for classroom observation, but expresses a major concern about reliability of observations. The author points to two primary ways to increase the reliability of classroom observations. The first is to narrow the range of what is looked for by having a system that takes a narrowed focus on teaching (for instance, an observation system based on the Madeline Hunter approach to instruction), or by using an observation guide or focusing instrument. The second way is to use a pre-conference to increase the kind and amount of information the observer has prior to the observation. Glatthorn (1984) recommends that clinical supervisors (or coaches) alternate unfocused observations with focused observations. In unfocused observation the observer usually takes verbatim notes on all significant behavior. These data are used to identify some strengths and potential problems that are discussed in a problem-solving feedback conference. A focus is then determined for the next observation, during which the observer gathers data related to the identified problem.

Glickman (1986) suggests that the type of feedback provided teachers should be based on their cognitive levels. Teachers with a "low abstract" cognitive style should receive directive conferences (problem identification and solution come primarily form the coach or supervisor); "moderate-abstract" teachers should receive collaborative conferences (an exchange of perceptions about problems and a negotiated solution); and "high-abstract" teachers should receive a non-directive approach (the coach or supervisor helps the teacher clarify problems and choose a course of action).

Peer coaching is a form of the observation/assessment model that promotes transfer of learning to the classroom (Joyce & Showers, 1982). In peer observation, teachers visit one another's classrooms, gather objective data about student performance or teacher behavior, and give feedback in a follow-up conference. According to Joyce and Showers (1983):

> *Relatively few persons, having mastered a new teaching skill, will then transfer that skill into their active repertoire. In fact, few will use it at all. Continuous practice, feedback, and the companionship of coaches is essential to enable even highly motivated persons to bring additions to their repertoire under effective control. (p. 4)*

Joyce (Brandt, 1987) says that up to 30 trials may be required to bring a new teaching strategy under "executive control." Similarly, Shalaway (1985) found that 10 to 15 coaching sessions may be necessary for teachers to use what they have learned in their classrooms.

Phases of activity. The observation/assessment model — whether implemented through evaluation, clinical supervision, or peer coaching — usually includes a pre-observation conference, observation, analysis of data, post-observation conference, and (in some instances) an analysis of the observation/assessment process (Loucks-Horsley et al., 1987). In the pre-observation conference, a focus for the observation is determined, observation methods selected, and any special problems noted.

During the observation, data are collected using the processes agreed upon in the pre-observation conference. The observation may be focused on the students or on the teacher, and can be global in nature or narrowly focused. Patterns found during instruction may become evident. Hunter (1982) recommends three points of analysis: (a) behaviors that contribute to learning, (b) behaviors that interfere with learning, and (c) behaviors that neither contribute nor interfere, but use time and energy that could be better spent.

In the post-observation conference both the teacher and observer reflect on the lesson and the observer shares the data collected. Strengths are typically acknowledged and areas for improvement suggested (by either the teacher or observer, depending upon the goals established in the pre-observation conference). An analysis of the supervisory (or coaching) process itself, while not necessarily a part of all forms of this model, provides participants with an opportunity to reflect on the value of the observation/assessment process and to discuss modifications that might be made in future cycles.

Illustrations and outcomes. Acheson and Gall (1980) report a number of studies in which the clinical supervision model has been accepted by teachers when they and their supervisors are taught systematic observation techniques. They further note that this process is viewed as productive by teachers when the supervisor uses "indirect" behaviors (e.g., accepting feelings and ideas, giving praise and encouragement, asking questions). While the authors report that trained supervisors helped teachers make improvements in a number of instructional behaviors, they were unable to find any studies that demonstrated *student effects*.

The most intensive and extensive studies of the impact of observation/assessment on learning comes from the work of Showers and Joyce. Discussed in more detail in the training section, these authors and their associates have found that powerful improvements have been made to student learning when the training of teachers in effective instructional practices is followed by observations and coaching in their classrooms (Joyce & Showers, 1988). In a study that contrasted different sources of coaching, Sparks (1986) contrasted a workshop-only approach with peer coaching and with consultant coaching. Her findings indicated that peer coaching was most powerful in improving classroom performance.

The research, then, provides reason to believe that teacher behaviors can be positively influenced by the use of an observation/assessment model of staff development.

The research, then, provides reason to believe that teacher behaviors can be positively influenced by the use of an observation/assessment model of staff development. It still remains to be learned, however, whether this model must be combined with particular kinds of training if student learning is to be enhanced.

3. Involvement in a Development/Improvement Process

Teachers are sometimes asked to develop or adapt curriculum, design programs, or engage in systematic school improvement processes that have as their goal the improvement of classroom instruction and/or curriculum. Typically these projects are initiated to solve a problem. Their successful completion may require that teachers acquire specific knowledge or skills (e.g., curriculum planning, research on effective teaching, group problem-solving strategies). This learning could be acquired through reading, discussion, observation, training, and/or trial and error. In other instances, the process of developing a product itself may cause significant learnings (e.g., through experiential learning), some of which may have been difficult or impossible to predict in advance. This model focuses on the combination of learnings that result from the involvement of teachers in such development/improvement processes.

Underlying assumptions. One assumption on which this model is based is that adults learn most effectively when they have a need to know or a problem to solve (Knowles, 1980). Serving on a school improvement committee may require that teachers read the research on effective teaching and that they learn new group and interpersonal skills. Curriculum development may demand new content knowledge of teachers. In each instance, teachers' learning is driven by the demands of problem solving.

Another assumption of this model is that people working closest to the job best understand what is required to improve their performance. Their teaching experiences guide teachers as they frame problems and develop solutions. Given appropriate opportunities, teachers can effectively bring their unique perspectives to the tasks of improving teaching and their schools.

A final assumption is that teachers acquire important knowledge or skills through their involvement in school improvement or curriculum development processes. Such involvement may cause alterations in attitudes or the acquisition of skills as individuals or groups work toward the solution of a common problem. For instance, teachers may become more aware of the perspectives of others, more appreciative of individual differences, more skilled in group leadership, and better able to solve problems. While the learnings may be unpredictable in advance, they are often regarded as important by teachers.

Teachers acquire important knowledge or skills through their involvement in school improvement or curriculum development processes. Such involvement may cause alterations in attitudes or the acquisition of skills as individuals or groups work toward the solution of a common problem.

Theoretical and research underpinnings. We have chosen to represent curriculum development and school improvement as types of staff development; involvement in these processes nurtures teachers' growth. Others see staff development (perhaps viewed more narrowly as training) as a key component of effective curriculum development and implementation. As Joyce and Showers (1988) write, "It has been well established that curriculum implementation is demanding of staff development — essentially, without strong staff development programs that are appropriately designed a very low level of implementation occurs" (p. 44).

Whichever perspective one has, staff development and the improvement of schools and curriculum go hand in hand. Glickman (1986), who argues that the aim of staff development should be to improve teachers' ability to think, views curriculum development as a key aspect of this process. He believes that the intellectual engagement required in curriculum development demands that teachers not only know their content, but that they must also acquire curriculum planning skills. He recommends that curriculum development be conducted in heterogeneous groups composed of teachers of low, medium, and high abstract reasoning abilities. According to Glickman, the complexity of the curriculum development task should be matched to the abstract reasoning ability of the majority of teachers in the group.

Glatthorn (1987) describes three ways in which teachers can modify a district's curriculum guide. They may operationalize the district's curriculum guide by taking its lists of objectives and recommended teaching methods and turning them into a set of usable instructional guides. Or they may adapt the guide to students' special needs (e.g., remediation, learning style differences, etc.). Finally, teachers may enhance the guide by developing optional enrichment units. Glatthorn recommends that these activities be done in groups, believing that, in doing so, teachers will become more cohesive and will share ideas about teaching and learning in general, as well as on the development task at hand.

The involvement of teachers in school improvement processes, while similar in its assumptions and process to curriculum development, finds its research and theory base in other sources. General approaches to school improvement come from the literature on change and innovation. For example, Loucks-Horsley and Hergert (1985) describe seven action steps in a school improvement process that are based in research on implementation of new practices in schools (Crandall & Loucks, 1983; Hall & Loucks, 1978; Louis & Rosenblum, 1981). The research on effective schools underpins other approaches to school improvement (Cohen, 1981). Finally, an approach to school improvement through staff development developed by Wood and his associates was derived from an analysis of effective staff development practices as represented in the research and in reports from educational practitioners (Thompson, 1982; Wood, 1989). The result is a five-stage RPTIM model (Readiness, Planning, Training, Implementation, and Maintenance) used widely in designing and implementing staff development efforts (Wood, Thompson, & Russell, 1981). As a result of involvement in such improvement efforts, schools (and the teachers within them) may develop new curriculum, change reporting procedures to parents, enhance communication within the faculty, and improve instruction, among many other topics.

Phases of activity. This model begins with the identification of a problem or need by an individual, a group of teachers (e.g., a grade-level team or a secondary department), a school faculty, or a district administrator. The need may be identified informally through discussion or a growing sense of dissatisfaction, through a more formal process such as brainstorming or the use of a standardized instrument (such as a school improvement survey or needs assessment), or through examination of student achievement or program evaluation data.

After a need has been identified, a response is formulated. This response may be determined informally or formally. In some cases, the necessary action may become immediately evident (e.g., the need for new lunchroom rules). At other times, teachers may need to brainstorm or search out alternatives, weigh them against a set of predetermined criteria, develop an ac-

BEST COPY AVAILABLE

tion plan, and determine evaluation procedures. This process may take several sessions to complete and require consultation with a larger group (e.g., the schoolwide staff development committee may receive feedback on the tentative plan from the entire faculty).

Typically it becomes evident during this phase that specific knowledge or skills may be required to implement the plan. For instance, the faculty may decide that it wants to study several discipline systems before implementing the new lunchroom management system. The improvement of students' higher-order thinking may involve the selection of new textbooks, requiring that committee members better understand which features to look for in a textbook to support this goal. The development or selection of a new elementary science curriculum may require study of the latest research on science teaching and the examination of other curricula.

At this point the plan is implemented or the product developed. This process may take several days, several months, or several years. As a final step, the success of the program is assessed. If teachers are not satisfied with the results, they may return to an earlier phase (e.g., acquisition of knowledge or skills) and repeat the process.

Illustrations and outcomes. While teachers have long been involved in curriculum development, little research on the impact of these experiences on their professional development has been conducted. The research that has been done has assessed the impact of such involvement on areas other than professional development (for example, job satisfaction, costs, and commitment to the organization) (Kimpston & Rogers, 1987). Similarly, although the engagement of teachers in school improvement processes has increased in the last few years, little research has been conducted on the effects of that involvement on their professional development. There are, however, numerous examples that illustrate the various ways schools and districts have enhanced teacher growth by engaging them in the development/improvement process.

In the past few years, many state education agencies have supported implementation of state-initiated reforms through the encouragement (and sometimes mandating) of school improvement processes. For example, the Franklin County (Ohio) Department of Education used a staff development process to assist five school districts to meet mandated state goals (Scholl & McQueen, 1985). Teachers and administrators from the districts learned about the state requirements and developed goals and planning strategies for their districts. A major product of the program was a manual that included a synthesis of information and worksheets that could be used to guide small group activities in the five districts.

School districts have also initiated programs which involved teachers in improvement planning. In the Hammond (Indiana) Public Schools, decision making is school based (Casner-Lotto, 1988). School improvement committees (each composed of 15-20 members, including teachers, administrators, parents, students, and community members) received training in consensus building, brainstorming, creative problem solving, and group dynamics. After this training, each committee develops a "vision of excellence" for its school. As a result, schools have initiated projects in individualized learning, peer evaluation, cross-grade-level reading, and teacher coaching/mentoring.

Sparks, Nowakowski, Hall, Alec, and Imrick (1985) reported on two elementary school improvement projects that led to large gains on state reading tests. The first school's staff decided to review the reading curriculum and to investigate alternative instructional approaches. Teachers task-analyzed the six lowest-scoring objectives on the state test, studied effective instructional techniques, and participated in self-selected professional growth activities. In 2 years the number of students who scored above the average rose from 72 percent to 100 percent. In the second school, teachers adopted a new reading series, revised the kindergarten program, and created a booklet that included practice test items and effective instructional practices for improving student achievement. The percentage of students achieving the reading objectives increased almost 20 percent in 3 years.

The Jefferson County (Colorado) School District has long involved teachers in curriculum development and adaptation (Jefferson County Public Schools, 1974). A cyclical process of needs assessment, curriculum objective statements, curriculum writing, pilot testing and evaluation, and district-wide implementation has been used on a regular basis in the majorontent areas. Teachers involved in writing and pilot test teams hone their skills as curriculum planners and developers and as masters of the new techniques that are incorporated into the curriculum (these have included such strategies as cooperative learning and individualized instruction). They also often take on the role of teacher trainers for the district-wide implementation that follows pilot and field tests (Loucks & Pratt, 1979).

E. J. Wilson High School in Spencerport (New York) is one of many across the country that has implemented elements of effective schools through a systematic school improvement process. Teachers in the school participate with building administrators on a Building Planning Committee which spearheads the achievement of "ideal practices" within the school through a seven-step process that engages the entire faculty in assessment, planning, implementation, and evaluation. As a result, the school climate and student achievement have improved, as have the knowledge, skills, and attitudes of the teachers involved. This school's outcome is representative of other schools that have implemented similar improvement processes (Kyle, 1985).

These state, school, and district-level efforts illustrate the wide variety of ways in which this model of staff development is being used. While the research and evaluation evidence regarding the impact of these processes on teacher knowledge and skills is not substantial, research does support many of the ingredients contained within these processes. These include commitment to the process by school and building administrators, which includes giving authority and resources to the team to pursue and then implement its agenda; development of knowledge and skills on the part of the teacher participants; adequate, quality time to meet, reflect, and develop; adequate resources to purchase materials, visit other sites, hire consultants to contribute to informed decision making; leadership that provides a vision, direction and guidance, but allows for significant decision making on the part of the teacher participants; and integration of the effort into other improvement efforts and into other structures that influence teaching and learning in the school (Loucks-Horsley et al., 1987). When these factors are present, a limited amount of research data and a great deal of self-report data indicate clearly that the desired outcomes of staff development are achieved.

4. Training

In the minds of many educators, training is synonymous with staff development. Most teachers are accustomed to attending workshop-type sessions in which the presenter is the expert who establishes the content and flow of activities. Typically the training session is conducted with a clear set of objectives or learner outcomes. These outcomes frequently include awareness or knowledge (e.g., participants will be able to explain the five principles of cooperative learning) and skill development (e.g., participants will demonstrate the appropriate use of open-ended questions in a class discussion). Joyce and Showers (1988) cite changes in attitudes, transfer of training, and "executive control" (the appropriate and consistent use of new strategies in the classroom) as additional outcomes. It is the trainer's role to select activities (e.g., lecture, demonstration, role-playing, simulation, microteaching) that will aid teachers in achieving the desired outcomes.

Whatever the anticipated outcomes, the improvement of teachers' thinking is an important goal. According to Showers, Joyce, and Bennett (1987):

> *. . . the purpose of providing training in any practice is not simply to generate the external visible teaching "moves" that bring that practice to bear in the instructional setting but to generate the conditions that enable the practice to be selected and used appropriately and integratively. . . . a major, perhaps the major, dimension of teaching skill is cognitive in nature. (pp. 85-86)*

Underlying assumptions. An assumption that undergirds the training model of staff development is that there are behaviors and techniques that are worthy of replication by teachers in the classroom. This assumption can certainly be supported by the large number of research-based effective teaching practices that have been identified and verified in the past 20 years (Sparks, 1983).

Another assumption underlying this model is that teachers can change their behaviors and learn to replicate behaviors in their classroom that were not previously in their repertoire. As Joyce and Showers (1983) point out, training is a powerful process for enhancing knowledge and skills. "It is plain from the research on training," they say, "that teachers can be wonderful learners. They can master just about any kind of teaching strategy or implement almost any technique as long as adequate training is provided" (p. 2).

Because of a high participant-to-trainer ratio, training is usually a cost-efficient means for teachers to acquire knowledge or skills. Many instructional skills require that teachers view a demonstration of their use to fully understand their implementation. Likewise, certain instructional techniques require for their classroom implementation that teachers have an opportunity to practice them with feedback from a skilled observer. Training may be the most efficient means for large numbers of teachers to view these demonstrations and to receive feedback as they practice.

Theoretical and research underpinnings. The theoretical and research underpinnings for the training model come from several sources, but the most recent and intensive research has been conducted by Joyce and Showers (1988). They have determined that, depending upon the desired outcomes, training might include exploration of theory, demonstration or modeling of a skill, practice of the skill under simulated conditions, feedback about performance, and coaching in the workplace. Their research indicates that this combination of components is necessary if the outcome is skill development.

In addition to those components identified by Joyce and Showers, Sparks (1983) cites the importance of discussion and peer observation as training activities. She notes that discussion is useful both when new concepts or techniques are presented and as a problem-solving tool after teachers have had an opportunity to try out new strategies in their classrooms. Training sessions that are spaced 1 or more weeks apart so that content can be "chunked" for improved comprehension and so that teachers have opportunities for classroom practice and peer coaching are shown to be more effective than "one-shot" training (Loucks-Horsley et al., 1987; Sparks, 1983).

Sparks (1983), Wu (1987), and Wood and Kleine (1987) point out the value of teachers as trainers of their peers. Sparks indicates that teachers may learn as much from their peers as from "expert" trainers. She also argues that school districts can afford the type of small-group training that she recommends when peers are used rather than more expensive external consultants. In reviewing the research, Wood and Kleine found that teachers preferred their peers as trainers. Wu's review of the research also confirmed this, finding that when their peers are trainers, teachers feel more comfortable exchanging ideas, play a more active role in workshops, and report that they receive more practical suggestions. There is, however, evidence that indicates that expert trainers who have the critical qualities teachers value in their peers (e.g., a clear understanding of how a new practice works with real students in real classroom settings) can also be highly effective (Crandall, 1983).

Phases of activities. According to Joyce and Showers (1988), "Someone has to decide what will be the substance of the training, who will provide training, when and where the training will be held and for what duration" (p. 69). While training content, objectives, and schedules are often determined by administrators or by the trainer, Wood, McQuarrie, and Thompson's (1982) research-based model advocates involving participants in planning training programs. Participants serve on planning teams which assess needs (using appropriate sources of data), explore various research-based approaches, select content, determine goals and objectives, schedule training sessions, and monitor implementation of the program.

Joyce and Showers (1988) point out that there are specific "learning-to-learn" attitudes and skills that teachers possess or can develop that aid the training process. They cite persistence, acknowledgment of the transfer problem (the need for considerable practice of new skills in the classroom), teaching new behaviors to students, meeting the cognitive demands of innovations (developing a "deep understanding" of new practices), the productive use of peers, and flexibility. The authors list several conditions of training sessions that foster these aptitudes and behaviors: adequate training, opportunities for collegial problem solving, norms that encourage experimentation, and organizational structures that support learning. Sparks' (1983) review of staff development research suggests that a diagnostic process (such as detailed profiles of teaching behaviors based upon classroom observations) may be an important first step in the training process.

After training, in-classroom assistance in the form of peer observation and coaching is critical to the transfer of more complex teaching skills (Joyce & Showers, 1988). The process of data gathering and analysis that accompanies most forms of peer observation is valuable to the observer as well as the observed teacher (Brandt, 1987; Sparks, 1986). A more thorough discussion of this topic can be found in the observation/assessment model described earlier in this article.

Illustrations and outcomes. The power of training to alter teachers' knowledge, attitudes, and instructional skills is well established. Its impact on teachers, however, depends upon its objectives and the quality of the training program. Joyce and Showers (1988) have determined that when all training components are present (theory, demonstration, practice, feedback, and coaching), an effect size of 2.71 exists for knowledge-level objectives, 1.25 for skill-level objectives, and 1.68 for transfer of training to the classroom. (The effect size describes the magnitude of gains from any given change in educational practice; the higher the effect size, the greater the magnitude of gain. For instance, an effect size of 1.0 indicates that the average teacher in the experimental group outperformed 84% of the teachers in the control group.) "We have concluded from these data," Joyce and Showers (1988) report, "that teachers can acquire new knowledge and skill and use it in their instructional practice when provided with adequate opportunities to learn" (p. 72). Coaching and peer observation research cited earlier in the observation/assessment model also supports the efficacy of training.

Wade (1985) found in her meta-analysis of inservice teacher education research that training affected participants' learning by an effect size of .90 and their behavior by .60. An effect size of .37 was found for the impact of teacher training on student behavior. Wade also concluded that training groups composed of both elementary and secondary teachers achieved higher effect sizes than did those enrolling only elementary or only secondary teachers.

Gage (1984) traces the evolution of research on teaching from observational and descriptive studies to correlational studies to nine experiments that were designed to alter instructional practices. "The main conclusion of this body of research," Gage wrote, "is that, in eight out of the nine cases, inservice education was fairly effective — not with all teachers and not with all teaching practices but effective enough to change teachers and improve student achievement, or attitudes, or behavior" (p. 92).

Numerous specific illustrations of training programs are available that have demonstrated impact on teacher behavior and/or student learning. For instance, studies indicate that teachers who have been taught cooperative learning strategies for their classrooms have students who have higher achievement, display higher reasoning and greater critical thinking, have more positive attitudes toward the subject area, and like their fellow students better (Johnson, Johnson, Holubec, & Roy, 1984).

Good and Grouws (1987) describe a mathematics staff development program for elementary teachers. In this 10-session program teachers learned more about mathematics content and about instructional and management issues. As a result of the training, the researchers found changes in teachers' classroom practice and improved mathematics presentations. Student mathematics performance was also improved.

Kerman (1979) reports a 3-year study in which several hundred K-12 teachers were trained to improve their interactions with low-achieving students. The five-session training program included peer obser tion in the month interval between e session. The researchers found that l achieving students in experimental clas made significant academic gains over th counterparts in control groups.

As the preceding discussion indicates, there is a much more substantial research literature on training than on the models presented earlier. Under the appropriate conditions, training has the potential for significantly changing teachers' beliefs, knowledge, behavior, and the performance of their students.

Rauth (1986) describes an American Federation of Teachers training program that brought research on teaching to its members. Teacher Research Linkers (TRLs) first determine which aspects of the research will be most valuable in their teaching. Between sessions they carry out implementation plans in their own classrooms. TRLs are then taught how to effectively share this research with their colleagues. A study of this program indicated that teachers made significant changes in their practice and that, in addition, their morale and collegiality increased dramatically.

Robbins and Wolfe (1987) discuss a 4-year staff development project designed to increase elementary students' engaged time and achievement. Evaluation of the training program documented steady improvement for 3 years in teachers' instructional skills, student engaged time, and student achievement in reading and math. While scores in all these areas dropped in the project's fourth and final year, Robbins and Wolfe argue that this decline was due to insufficient coaching and peer observation during that year.

As the preceding discussion indicates, there is a much more substantial research literature on training than on the models presented earlier. Under the appropriate conditions, training has the potential for significantly changing teachers' beliefs, knowledge, behavior, and the performance of their students.

5. **Inquiry**

Teacher inquiry can take different forms. A high school teacher wonders if an alteration in her lesson plan from her first period class will produce improved student understanding in second period. A brief written quiz given at the end of the class indicates that it did. A group of teachers gathers weekly after school for an hour or two at the teacher center to examine the research on ability grouping. Their findings will be shared with the district's curriculum council. Several elementary teachers study basic classroom research techniques, formulate research questions, gather and analyze data, and use their findings to improve instruction in their classrooms.

Teacher inquiry may be a solitary activity, be done in small groups, or be conducted by a school faculty. Its process may be formal or informal. It may occur in a classroom, at a teacher center, or result from a university class. In this section teacher inquiry is explored as a staff development model.

One of the important tenets of the inquiry approach is that research is an important activity in which teachers should be engaged, although they rarely participate in it other than as "subjects."

Underlying assumptions. Inquiry reflects a basic belief in teachers' ability to formulate valid questions about their own practice and to pursue objective answers to those questions. Loucks-Horsley and her associates (1987) list three assumptions about a teacher inquiry approach to staff development:

- Teachers are intelligent, inquiring individuals with legitimate expertise and important experience.
- Teachers are inclined to search for data to answer pressing questions and to reflect on the data to formulate solutions.
- Teachers will develop new understandings as they formulate their own questions and collect their own data to answer them.

The overarching assumption of the model is that

> *the most effective avenue for professional development is cooperative study by teachers themselves into problems and issues arising from their attempts to make their practice consistent with their educational values. . . . [The approach] aims to give greater control over what is to count as valid educational knowledge to teachers. (Ingvarson, 1987, pp. 15, 17)*

Theoretical and research underpinnings. The call for inquiry-oriented teachers is not new. Dewey (1933) wrote of the need for teachers to take "reflective action." Zeichner (1983) cites more than 30 years of advocacy for "teachers as action researchers," "teacher scholars," "teacher innovators," "self-monitoring teachers," and "teachers as participant observers."

More recently, various forms of inquiry have been advocated by a number of theorists and researchers. Tikunoff and Ward's (1983) model of interactive research and development promotes teacher inquiry into the questions they are asking through close work with researchers (who help with methodology) and staff developers (who help them create ways of sharing their results with others). Lieberman (1986) reports on a similar process in which teachers serving on collaborative teams pursued answers to school-wide rather than classroom problems. Watts (1985) discusses the role of collaborative research, classroom action research, and teacher support groups in encouraging teacher inquiry. Simmons and Sparks (1985) describe the use of action research to help teachers better relate research on teaching to their unique classrooms.

Glickman (1986) advocates action research in the form of quality circles, problem-solving groups, and school improvement projects as means to develop teacher thought. Cross (1987) proposes classroom research to help teachers evaluate the effectiveness of their own teaching. Glatthorn (1987) discusses action research by teams of teachers as a peer-centered option for promoting professional growth. Loucks-Horsley and her colleagues (1987) discuss teachers-as-researchers as a form of teacher development that helps narrow the gap between research and practice. Sparks and Simmons (1989) propose inquiry-oriented staff development as a means to enhance teachers' decision-making abilities.

One of the important tenets of the inquiry approach is that research is an important activity in which teachers should be engaged, although they rarely participate in it other than as "subjects." Gable and Rogers (1987) "take the terror out of research" by describing ways in which it can be used as a staff development tool. They discuss both qualitative and quantitative methodology, providing specific strategies that teachers can use in their classrooms. They conclude by saying ". . . the desire to and ability to do research is an essential attribute of the professional teacher of the Eighties" (p. 695).

Phases of activity. While the inquiry model of staff development can take many forms, these forms have a number of elements in common. First, individuals or a group of teachers identify a problem of interest. Next, they explore ways of collecting data that may range from examining existing theoretical and research literature to gathering original classroom or school data. These data are then analyzed and interpreted by an individual or the group. Finally, changes are made, and new data are gathered and analyzed to determine the effects of the intervention.

This process can be adapted to the unique needs of a particular approach to inquiry. For instance, Hovda and Kyle (1984) provide a 10-step process for action research that progresses from identifying interested participants, through sharing several study ideas, to discussing findings, to considering having the study published or presented. Glatthorn (1987) describes a four-step process for action research. Collaborative research teams (a) identify a problem, (b) decide upon specific research questions to be investigated and methodology to be used, (c) carry out the research design, and (d) use the research to design an intervention to be implemented in the school.

Watts (1985) describes "reflective conversations" in which teachers carefully observe and thoughtfully consider a particular child or practice. Using a standard procedure, the group shares observations, reviews previous records and information, summarizes their findings, and makes recommendations. As a final step, the group reviews the process to assess how well it went, looks for gaps, and identifies ideas to repeat in future conversations.

Organizational support and/or technical assistance may be required throughout the phases of an inquiry activity. Organizational support may take the form of structures such as teacher centers or study groups, or of resources such as released time or materials. Technical assistance may involve training in research methodologies, data-gathering techniques, and other processes that aid teachers in making sense of their experiences.

Illustrations and outcomes. The forms inquiry as a staff development model may take are limited only by the imagination. Simmons and Sparks (1985) describe a "Master of Arts in Classroom Teaching" degree designed to help teachers meet their individually identified improvement goals. Teachers in this program learn about educational research, identify and analyze classroom problems, pursue topics of professional interest, and improve their overall teaching ability. The authors report evidence of change in participant knowledge (e.g., concerning effective teaching-learning), thinking (e.g., enhanced problem-solving skills, increased cognitive complexity), and patterns of communication and collegiality.

Teacher development in school districts does not take place in a vacuum. Its success is influenced in many ways by the district's organizational context.

Watts (1985) presents a number of ways in which teachers act as researchers. She discussed collaborative research in teacher centers funded by the Teachers' Center Exchange (then located at the Far West Laboratory for Educational Research and Development) that was conducted in the late 1970s and early 1980s. Fourteen projects were funded in which teachers collaborated with researchers on topics of interest to the individual teachers' center. Watts also described ethnographic studies of classrooms conducted collaboratively by teachers and researchers. In addition, she provided examples of classroom action research and teachers' study groups as forms of inquiry. Watts concluded that these three approaches share several outcomes. First, as a result of learning more about research, teachers make more informed decisions about when and how to apply the research findings of others. Second, teachers experience more supportive and collegial relationships. And third, teaching improves as teachers learn more about it by becoming better able to look beyond the immediate, the individual, and the concrete.

The effects of the teacher inquiry model of staff development may reach beyond the classroom to the school. An example of school-wide impact comes from the report of a high school team convened to reflect on a lack of communication and support between teachers and administrators (Lieberman & Miller, 1984). As a result of working together to define the problem, learn each other's perspectives, gather evidence, and formulate solutions, teachers and administrators address important school problems collaboratively. Note that there is a substantial overlap between this kind of "school-based" inquiry and some of the school improvement processes discussed earlier in the model described as involvement in a development/improvement process.

Organizational Context

Teacher development in school districts does not take place in a vacuum. Its success is influenced in many ways by the district's organizational context (McLaughlin & Marsh, 1978; Sparks, 1983). Key organizational factors include school and district climate, leadership attitudes and behaviors, district policies and systems, and the involvement of participants.

While staff development fosters the professional growth of individuals, organizational development addresses the organization's responsibility to define and meet changing self improvement goals (Dillon-Peterson, 1981). Consequently, effective organizations have the capacity to continually renew themselves and solve problems. Within this context, individuals can grow.

In earlier sections of this article, five models of staff development were discussed that have solid foundations in research and/or practice, and are being used in increasingly robust forms throughout the country today. While each model requires somewhat different organizational supports to make it successful, it is also true that research points to a common set of attributes of the organizational context without which staff development can have only limited success (Loucks-Horsley et al., 1987). In organizations where staff development is most successful:

- Staff members have a common, coherent set of goals and objectives that they have helped formulate, reflecting high expectations of themselves and their students.
- Administrators exercise strong leadership by promoting a "norm of collegiality," minimizing status differences between themselves and their staff members, promoting informal communication, and reducing their own need to use formal controls to achieve coordination.
- Administrators and teachers place a high priority on staff development and continuous improvement.
- Administrators and teachers make use of a variety of formal and informal processes for monitoring progress toward goals, using them to identify obstacles to such progress and ways of overcoming these obstacles, rather than using them to make summary judgments regarding the "competence" of particular staff members (Conley & Bacharach, 1987).
- Knowledge, expertise, and resources, including time, are drawn on appropriately, yet liberally, to initiate and support the pursuit of staff development goals.

This section briefly highlights the research that supports these organizational attributes.

Organizational Climate

Little (1982) found that effective schools are characterized by norms of collegiality and experimentation. Simply put, teachers are more likely to persist in using new behaviors when they feel the support of colleagues and when they believe that professional risk taking (and its occasional failures) are encouraged. Fullan (1982) reports that the degree of change is strongly related to the extent to which teachers interact with each other and provide technical help to one another. "Teachers need to participate in skill-training workshops," Fullan writes, "but they also need to have one-to-one and group opportunities to receive and give help, and more simply to converse about the meaning of change" (p. 121).

The degree of change is strongly related to the extent to which teachers interact with each other and provide technical help to one another.

Joyce and Showers (1983) point out that "in a loose and disorganized social climate without clear goals, reticent teachers may actually subvert elements of the training process not only for themselves but also for others" (p. 31). While teacher commitment is desirable, it need not necessarily be present initially for the program to be successful. Miles (1983) found that teacher/administrator harmony was critical to the success of improvement efforts, but that it could develop over the course of an improvement effort. Initially, working relationships between teachers and administrators had to be clear and supportive enough so that most participants could "suspend disbelief," believing that the demands of change would be dealt with together (Crandall, 1983). In their study of school improvement efforts that relied heavily on staff development for their success, both Miles and Crandall found that in projects where a mandated strategy caused some initial disharmony between teachers and administrators, the climate changed as the new program's positive impact on students became clear. When a new program was selected carefully and teachers received good training and support, most who were initially skeptical soon agreed with and were committed to the effort. Showers, Joyce, and Bennett (1987) support the position that, at least initially, teachers' ability to use a new practice in a competent way may be more important than commitment.

Few would disagree with the importance of a school and district climate that encourages experimentation and supports teachers to take risks, i.e., establishes readiness for change (Wood, Thompson, & Russell, 1981). Yet a supportive context consists of more than "good feelings." The quality of the recommended practices is also critical. Research conducted by Guskey (1986) and Loucks and Zacchei (1983) indicates that the new practices developed or chosen by or for teachers need to be effective ones — effective by virtue of evaluation results offered by the developer or by careful testing by the teachers who have developed them. These researchers found that only when teachers see that a new program or practice enhances the learning of their students will their beliefs and attitudes change in a significant way.

Leadership and Support

According to the Rand Change Agent Study (McLaughlin & Marsh, 1978) active support by principals and district administrators is critical to the success of any change effort. According to McLaughlin and Marsh (1978):

> *The Rand research sets the role of the principal as instructional leader in the context of strengthening the school improvement process through team building and problem solving in a "project-like" context. It suggests that principals need to give clear messages that teachers may take responsibility for their own professional growth. (p. 92)*

Stallings and Mohlman (1981) determined that teachers improved most in staff development programs where the principal supported them and was clear and consistent in communicating school policies. Likewise, Fielding and Schalock (1985) report a study in which principals' involvement in teachers' staff development produced longer-term changes than when principals were not involved.

In their discussion of factors that affect the application of innovations, Loucks and Zacchei (1983) wrote ". . . administrators in successful improvement sites take their leadership roles seriously and provide the direction needed to engage teachers in the new practices" (p. 30).

According to Huberman (1983), teachers' successful use of new skills often occurs when administrators exert strong and continuous pressure for implementation. He argues that ". . . administrators, both at the central office and building levels, have to go to center stage and stay there if school improvement efforts are to succeed" (p. 27). While administrator presence is important, administrators must also act as gate-keepers of change so that "innovation overload" can be avoided (Anderson & Odden, 1986).

While much research points to administrators as being key leaders in staff development and change, it is also true that others can take on leadership and support roles — and may in fact be better placed to do so. Research on school improvement indicates that a team approach can help orchestrate leadership and support "functions" which can be shared by administrators (building and district level), district coordinators or staff developers, teachers, and external trainers and consultants (Loucks-Horsley & Hergert, 1985). For example, Cox (1983) reports that while principals seem to play an important role in clarifying expectations and goals and stabilizing the school organization, central office coordinators, who often know more about a specific practice, can effectively coach teachers in their attempts to change their classroom behavior. Coordinated leadership can also help avoid situations such as a school's textbooks and curriculum not matching the instructional models teachers are being taught to use (Fielding & Schalock, 1985).

District Policies and Systems

Staff development activities occur within the context of a school district's staff development program. According to Ellis (1988), a comprehensive staff development program includes a philosophy, goals, allocation of resources, and coordination. The philosophy spells out beliefs that guide the program. District, school, and individual goals (and their accompanying action plans) provide direction to staff development efforts. Resources need to be allocated at the district, school, and individual levels so that these goals have a reasonable chance of being achieved. Staff development programs need to be coordinated by individuals who have an assigned responsibility for this area. Ellis also supports the use of a district-level staff development committee to aid in coordination of programs.

> ***While much research points to administrators as being key leaders in staff development and change, it is also true that others can take on leadership and support roles — and may in fact be better placed to do so.***

The selection, incorporation, or combination of the models of staff development described in this article are the responsibility of the district's staff development structure. Decisions about their use need to match the intended outcomes if they are to be effective (Levine & Broude, 1989), but these decisions are also influenced by state and/or community initiatives aimed at the improvement of schools and/or teaching (Anderson & Odden, 1986).

Participant Involvement

Research clearly indicates that involving participants in key decisions about staff development is necessary for a program to have its greatest impact. According to Lieberman and Miller (1986), a supportive context for staff development requires both a "top-down" and "bottom-up" approach. The top-down component sets a general direction for the district or school and communicates expectations regarding performance. The bottom-up processes involve teachers in establishing goals and designing appropriate staff development activities.

The establishment of common goals is important to the success of staff development efforts (Ward & Tikunoff, 1981). Odden and Anderson's (1986) research indicates that a clearly defined process of data collection, shared diagnosis, and identification of solutions to problems must be employed during the planning phase. Collaboration, from initial planning through implementation and institutionalization, is a key process in determining these goals and in influencing lasting change (Lambert, 1984; McLaughlin & Marsh, 1978; Wood, Thompson, & Russell, 1981).

Lortie (1986) argues that when teachers perceive that they can participate in important school-level decisions, the relationship between the extra efforts required by school improvement and the benefits of these efforts becomes clearer. Following this argument, he recommends that schools be given relatively little detailed supervision, but be monitored instead for results based on explicit criteria.

Others report that, when teachers cannot be involved in initial decisions regarding staff development (e.g., when it is mandated by state legislation or when it supports the use of district-wide curriculum), their involvement in decisions about the "hows" and "whens" of implementation can be important to success. Furthermore, teachers' involvement in developing curriculum and as trainers for staff development programs can contribute in important ways to the success of an effort (Loucks & Pratt, 1979).

Odden and Anderson (1986) capture the reciprocal relationship between organization and individual development in this discussion of their research:

> *When instructional strategies, which aim to improve the skills of individuals, were successful, they had significant effects on schools as organizations. When school strategies, which aim to improve schools as organizations, were successful, they had significant impacts on individuals. (p. 585)*

Staff development both influences and is influenced by the organizational context in which it takes place. The impact of the staff development models that have been discussed depends not only upon their individual or blended use, but upon the features of the organization in which they are used.

The importance of paying attention to the context of staff development is underscored by Fullan (1982). He responds to educators who say that they cannot provide the elements required to support change (e.g., supportive principals, a 2- or 3-year time period for implementation):

> *Well don't expect much implementation to occur . . . I say this not because I am a cynic but because it is wrong to let hopes blind us to the actual obstacles to change. If these obstacles are ignored, the experience with implementation can be harmful to the adults and children directly involved — more harmful than if nothing had been done. (p. 103)*

Conclusion

Staff development is a relatively young "science" within education. In many ways the current knowledge base in staff development is similar to what was known about teaching in the early 1970s. During the 1970s and early 1980s research on teaching advanced from descriptive to correlational to experimental (Gage, 1984). With the exception of research on training, much of the staff development literature is theoretical and descriptive rather than experimental. The remaining two sections describe what can be said with some confidence about the research base for the staff development models and what remains to be learned.

What Can Be Said with Confidence

Staff development possesses a useful "craft knowledge" that guides the field. This craft knowledge includes ways to organize, structure, and deliver staff development programs (Caldwell, 1989). It has been disseminated in the past decade through publications such as *The Journal of Staff Development*, *Educational Leadership*, and *Phi Delta Kappan*, and through thousands of presentations at workshops and conventions. As a result, in the past 20 years hundreds of staff development programs have been established in urban, suburban, and rural school districts throughout the United States and Canada. This craft knowledge serves another useful purpose: It can guide researchers in asking far better questions than they could have asked a decade ago.

Of the five models discussed in this article, the research on training is the most robust. It is the most widely used form of staff development and the most thoroughly investigated. As a result, it is possible to say with some confidence which training elements are required to promote the attainment of specific outcomes. Likewise, research on coaching has demonstrated the importance of in-classroom assistance to teachers (by an "expert" or by a peer) for the transfer of training to the classroom.

The consensus of "expert opinion" is that school improvement is a systemic process (Fullan, 1982). This ecological approach recognizes that changes in one part of a system influence the other parts. Consequently, staff development both influences and is influenced by the organizational context in which it takes place. The impact of the staff development models that have been discussed depends not only upon their individual or blended use, but upon the features of the organization in which they are used.

While this appears to relate to the "art" of making staff development work (i.e., the judgment with which one combines and juggles the various organizational interactions), there is also much "science" that can be drawn from when it comes to the organizational supports necessary for effective staff development. Study after study confirms the necessity of:

- Schools possessing norms that support collegiality and experimentation
- District and building administrators who work with staff to clarify goals and expectations, and actively commit to and support teachers' efforts to change their practice
- Efforts that are strongly focused on changes in curricular, instructional, and classroom management practices with improved student learning as the goal
- Adequate, appropriate staff development experiences with follow-up assistance that continues long enough for new behaviors to be incorporated into ongoing practice

Interestingly enough, it appears that these factors apply to a wide variety of school improvement and staff development efforts. While there are little hard research data on some of the models discussed above (see next section), most if not all of these factors will certainly persist as being important, regardless of what is learned about other models.

What We Need to Learn More About

While the work of staff developers during the past decade has been grounded in theory and research from various disciplines (e.g., adult learning, organization development, training), the scientific base of their own practice (with the exception of training and coaching) is quite thin. Unfortunately, the systematic study of some of the models discussed earlier is difficult because their use is not widespread or because they have been implemented only recently as part of comprehensive staff development programs. Listed below are areas for further study.

1. **We need research to determine the potency of the models described above (with the exception of training).** We need to learn which models are most effective for which outcomes with which teachers. For instance, we might ask: How effective is individually-guided staff development for knowledge level outcomes for self-directed experienced teachers? Or: How effective is an inquiry approach in helping beginning teachers learn their craft?

2. **We need a better understanding of the impact on student learning of the four non-training staff development models.** Do non-training models alter teacher knowledge or skills in a way that improves student learning?

3. **We need to know more about the impact on teachers of blending the models described above in a comprehensive staff development program.** How are teachers' attitudes, knowledge, and skills altered when they choose among and blend various models as the means of reaching one or more "growth" goals? For instance, what would be the result if a teacher blended individually-guided staff development (e.g., reading research on tracking), observation/assessment (e.g., peer observation), and training (e.g., in cooperative learning) as means to alter classroom practices that are viewed as disadvantageous to a sub-group of students?

4. **We need a systemic view of comprehensive staff development at the district level.** Most districts provide a variety of staff development opportunities to teachers. Some purposely support individual, school-based, and district-based activities. We need descriptive studies of what these programs look like, both from the overall, coordination point of view, and from the individual teacher point of view. We need to know: How are goals set and coordinated? How are resources allocated? How equitable are opportunities for individual teachers? How do different contextual factors (e.g., resources, state mandates) influence success?

5. **We need to understand more about the relative costs of different staff development models and combinations of the models.** Moore and Hyde (1978, 1979, 1981) have conducted some useful analyses of how many school district resources actually go for staff development purposes. But more micro-analyses would be useful to understand the cost-effectiveness of relatively labor-intensive models (e.g., coaching) versus those that rely only on the activity of a single teacher (e.g., individually-guided staff development).

6. **Finally, we need to look at staff development as it contributes to teacher professionalism and teacher leadership.** Many believe that teacher professionalism and leadership must characterize our education system in the future if that system is to survive. Yet there are as many different definitions of the terms as there are ideas of how to implement them. One role of staff development research is to help identify and clarify the various meanings given to these concepts. We then need descriptive studies of staff development's contributions to these efforts, with special attention to how these efforts influence the conduct of staff development.

It is possible that future research may contradict current craft knowledge (this, for example, has occurred with the learning that attitude change does not always have to precede behavior change), or, as is likely, future research will support current practice. Many questions about effective staff development remain unanswered. The need is great for well-designed, long-term studies of school improvement efforts that are based on staff development. The field of staff development seeks a solid base that moves beyond description and advocacy to a better understanding of those factors that support and improve classroom practice.

Reference Note

This article was adapted from "Models of Staff Development," in W. Robert Houston (Ed.), *Handbook of Research on Teacher Education*. New York: Macmillan, 1990.

References

Ainsworth, A. (1976). Teachers talk about inservice education. *Journal of Teacher Education, 27*, 107-109.

Anderson, B., & Odden, A. (1986). State initiatives can foster school improvement. *Phi Delta Kappan, 67*(8), 578-581.

Berman, P., & McLaughlin, M. (1978). *Federal programs supporting educational change: Vol. 8. Implementing and sustaining innovation.* Santa Monica, CA: Rand Corporation.

Blanchard, K., & Johnson, S. (1982). *The one minute manager.* New York: William Morrow.

Boyer, E. (1983). *High school: A report on secondary education in America.* New York: Harper & Row.

Brandt, R. (1982). On improving teacher effectiveness: A conversation with David Berliner. *Educational Leadership, 40*(1), 12-15.

Brandt, R. (1987). On teachers coaching teachers: A conversation with Bruce Joyce. *Educational Leadership, 44*(5), 12-17.

Brim, J., & Tollett, D. (1974). How do teachers feel about inservice education? *Educational Leadership, 31*, 21-25.

Caldwell, S. (Ed.) (1989). *Staff development: A handbook of effective practices.* Oxford, OH: National Staff Development Council.

Casner-Lotto, J. (1988). Expanding the teacher's role: Hammond's school improvement process. *Phi Delta Kappan, 69*(5), 349-353.

Cohen, M. (1981). Effective schools: What the research says. *Today's Education, 70*, 466-469.

Conley, S., & Bacharach, S. (1987). The Holmes Group report: Standards, hierarchies, and management. *Teachers College Record, 88*(3), 340-347.

Crandall, D. The teacher's role in school improvement. *Educational Leadership, 41*(3), 6-9.

Crandall, D., & Loucks, S. (1983). *A roadmap for school improvement.* Executive summary of *People, policies, and practices: Examining the chain of school improvement.* Andover, MA: The NETWORK, Inc.

Cross, P. (1987). The adventures of education in wonderland: Implementing education reform. *Phi Delta Kappan, 68*(7), 496-502.

Dewey, J. (1933). *How we think.* Chicago, IL: Henry Regnery Co.

Dillon-Peterson, B. (1981). Staff development/organizational development — perspective 1981. In B. Dillon-Peterson (Ed.), *Staff development/organization development* (pp.

1-10). Alexandria, VA: Association for Supervision and Curriculum Development.

Dunn, R., & Dunn, K. (1978). *Teaching students through their individual learning styles: A practical approach.* Reston, VA: Reston Publishing Co.

Ellis, S. (1989). Putting it all together: An integrated staff development program. In S. Caldwell (Ed.), *Staff development: A handbook of effective practices* (pp. 58-69). Oxford, OH: National Staff Development Council.

Fielding, G., & Schalock, H. (1985). *Promoting the professional development of teachers and administrators.* Eugene, OR: ERIC Clearinghouse on Educational Management. (ERIC Document Reproduction Service No. EA 017 747)

Fullan, M. (1982). *The meaning of educational change.* Toronto: OISE Press.

Gable, R., & Rogers, V. (1987). Taking the terror out of research. *Phi Delta Kappan, 68*(9), 690-695.

Gage, N. (1984). What do we know about teaching effectiveness? *Phi Delta Kappan, 66*(2), 87-93.

Glatthorn, A. (1984). *Differentiated supervision.* Alexandria, VA: Association for Supervision and Curriculum Development.

Glatthorn, A. (1987). Cooperative professional development: Peer-centered options for teacher growth. *Educational Leadership, 45*(3), 31-35.

Glickman, E. (1986). Developing teacher thought. *Journal of Staff Development, 7*(1), 6-21.

Good, T. (1981). Teacher expectations and student perceptions: A decade of research. *Educational Leadership, 38*(5), 415-422.

Good, T., & Grouws, D. (1987). Increasing teachers' understanding of mathematical ideas through inservice training. *Phi Delta Kappan, 68*(10), 778-783.

Gregorc, A. (1970). Learning/teaching styles: Their nature and effects. In *Student learning styles: Diagnosing and prescribing programs.* Reston, VA: National Association of Secondary School Principals.

Guskey, T. (1986). Staff development and the process of teacher change. *Educational Researcher, 15*(5), 5-12.

Hall, G., & Loucks, S. (1978). Teacher concerns as a basis for facilitating and personalizing staff development. *Teachers College Record, 80*(1), 36-53.

Hering, W., & Howey, K. (1982). *Research in, on, and by teachers' centers.* Occasional Paper No. 10. San Francisco, CA: Teachers' Center Exchange, Far West Laboratory for Educational Research and Development.

Hovda, R., & Kyle, D. (1984). A strategy for helping teachers integrate research into teaching. *Middle School Journal, 15*(3), 21-23.

Huberman, A. (1983). School improvement strategies that work: Some scenarios. *Educational Leadership, 41*(3), 23-27.

Hunter, M. (1982). *Mastery teaching.* El Segundo, CA: TIP Publications.

Ingvarson, L. (1987). *Models of inservice education and their implications for professional development policy.* Paper presented at a conference on "Inservice Education: Trends of the Past, Themes for the Future," Melbourne, Australia.

Jefferson County Public Schools (1974). *Report of the task force to define the process of developing curriculum.* Lakewood, CO: Author.

Johnson, D., Johnson, R., Holubec, E., & Roy, P. (1984). *Circles of learning.* Alexandria, VA: Association for Supervision and Curriculum Development.

Joyce, B., & Peck, L. (1977). *Inservice teacher education project report II: Interviews.* Syracuse, NY: Syracuse University.

Joyce, B., & Showers, B. (1982). The coaching of teaching. *Educational Leadership, 40*(1), 4-10.

Joyce, B., & Showers, B. (1983). *Power in staff development through research in training.* Alexandria, VA: Association for Supervision and Curriculum Development.

Joyce, B., & Showers, B. (1988). *Student achievement through staff development.* New York: Longman.

Joyce, B., & Weil, M. (1972). *Models of teaching.* Englewood Cliffs, NJ: Prentice-Hall.

Kells, P. (1981, January). Quality practices in inservice education. *The Developer.* Oxford, OH: National Staff Development Council.

Kerman, S. (1979). Teacher expectations and student achievement. *Phi Delta Kappan, 60*(10), 716-718.

Kidd, J. (1973). *How adults learn.* Chicago, IL: Follett Publishing Co.

Kimpston, R., & Rogers, K. (1987). The influence of prior perspectives, differences in participatory roles, and degree of participation on views about curriculum development: A case study. *Journal of Curriculum and Supervision, 2*(3), 203-220.

Knowles, M. (1980). *The modern practice of adult education.* Chicago, IL: Association/Follett Press.

Kyle, R. (Ed.) (1985). *Reaching for excellence: An effective school sourcebook.* Washington, DC: U.S. Government Printing Office.

Lambert, L. (1984). *How adults learn: An interview study of leading researchers, policy makers, and staff developers.* Paper presented at the annual meeting of the American Educational Research Association, New Orleans, LA.

Lawrence, G. (1974). *Patterns of effective inservice education: A state of the art summary of research on materials and procedures for changing teacher behaviors in inservice education.* Gainesville: University of Florida College of Education. (ERIC Document Reproduction Service No. ED 176 424)

Levine, S. (1989). *Promoting adult growth in schools: The promise of professional development.* Lexington, MA: Allyn & Bacon.

Levine, S., & Broude, N. (1989). Designs for learning. In S. Caldwell (Ed.), *Staff development: A handbook of effective practices.* Oxford, OH: National Staff Development Council.

Levine, S., & Jacobs, V. (1986). Writing as a staff development tool. *Journal of Staff Development, 7*(1), 44-51.

Lieberman, A. (1986). Collaborative research: Working with, not working on. *Educational Leadership, 43*(5), 28-32.

Lieberman, A., & Miller, L. (1984). *Teachers, their world and their work: Implications for school improvement.* Alexandria, VA: Association for Supervision and Curriculum Development.

Lieberman, A., & Miller, L. (1986). School improvement: Themes and variations. In A. Lieberman (Ed.), *Rethinking school improvement: Research, craft, and concept.* New York: Teachers College Press.

Little, J. (1982). Norms of collegiality and experimentation: Work-place conditions of school success. *American Educational Research Journal, 19*(3), 325-340.

Lortie, D. (1986). Teacher status in Dade County: A case of structural strain? *Phi Delta Kappan, 67*(8), 568-575.

Loucks, S., & Pratt, H. (1979). A concerns-based approach to curriculum change. *Educational Leadership, 37*(3), 212-215.

Loucks, S., & Zacchei, D. (1983). Applying our findings to today's innovations. *Educational Leadership, 41*(3), 28-31.

Loucks-Horsley, S., Harding, C., Arbuckle, M., Murray, L., Dubea, C., & Williams, M. (1987). *Continuing to learn: A guidebook for teacher development.* Andover, MA: Regional Laboratory for Educational Improvement of the Northeast and Islands, and the National Staff Development Council.

Loucks-Horsley, S., & Hergert, L. (1985). *An action guide to school improvement.* Alexandria, VA: Association for Supervision and Curriculum Development and Andover, MA: The NETWORK, Inc.

Louis, K., & Rosenblum, S. (1981). *Linking R & D with schools: A program and its implications for dissemination and school improvement policy.* Washington, DC: National Institute of Education.

Mann, D. (1984-85). Impact II and the problem of staff development. *Educational Leadership, 42*(4), 44-47.

Mathieson, D. (1987, December). Writing for professional growth. *The Developer.* Oxford, OH: National Staff Development Council.

McGreal, T. (1982). Effective teacher evaluation systems. *Educational Leadership, 39*(4), 303-305.

McGreal, T. (1983). *Successful teacher evaluation.* Alexandria, VA: Association for Supervision and Curriculum Development.

McLaughlin, M., & Marsh, D. (1978). Staff development and school change. *Teachers College Record, 80*(1), 69-94.

Miles, M. (1983). Unraveling the mystery of institutionalization. *Educational Leadership, 41*(3), 14-19.

Mosher, W. (1981). *Individual and systemic change mediated by a small educational grant program.* San Francisco, CA: Far West Laboratory for Educational Research and Development.

Odden, A., & Anderson, B. (1986). How successful state education improvement programs work. *Phi Delta Kappan, 67*(8), 582-585.

Rauth, M. (1986). Putting research to work. *American Educator, 10*(4), 26-31.

Robbins, P., & Wolfe, P. (1987). Reflections on a Hunter-based staff development project. *Educational Leadership, 44*(5), 56-61.

Rogers, C. (1969). *Freedom to learn.* Columbus, OH: Charles E. Merrill.

Scholl, S., & McQueen, P. (1985). The basic skills articulation plan: Curriculum development through staff development. *Journal of Staff Development, 6*(2), 138-142.

Shalaway, T. S. (1985). Peer coaching . . . does it work? *R & D Notes.* Washington, DC: National Institute of Education.

Showers, B. (1984). *Peer coaching: A strategy for facilitating transfer of training.* Eugene, OR: Center for Educational Policy and Management, University of Oregon.

Showers, B., Joyce, B., & Bennett, B. (1987). Synthesis of research on staff development: A framework for future study and a state-of-art analysis. *Educational Leadership, 45*(3), 77-87.

Simmons, J., & Sparks, G. (1985). Using research to develop professional thinking about teaching. *Journal of Staff Development, 6*(1), 106-116.

Sparks, G. (1983). Synthesis of research on staff development for effective teaching. *Educational Leadership, 41*(3), 65-72.

Sparks, G. (1986). The effectiveness of alternative training activities in changing teaching practices. *American Educational Research Journal, 23*(2), 217-225.

Sparks, G., Nowakowski, M., Hall, B., Alec, R., & Imrick, J. (1985). School improvement through staff development. *Educational Leadership, 42*(6), 59-61.

Sparks, G., & Simmons, J. (1989). Inquiry-oriented staff development: Using research as a source of tools, not rules. In S. Caldwell (Ed.), *Staff development: A handbook of effective practices* (pp. 126-139). Oxford, OH: National Staff Development Council.

Stallings, J., & Mohlman, G. (1981). *School policy, leadership style, teacher change, and student behavior in eight schools, final report.* Washington, DC: National Institute of Education.

Thompson, S. (1982). *A survey and analysis of Pennsylvania public school personnel perceptions of staff development practices and beliefs with a view to identifying some critical problems or needs.* Unpublished Dissertation, The Pennsylvania State University, University Park, PA.

Tikunoff, W., & Ward, B. (1983). Collaborative research on teaching. *The Elementary School Journal, 83*(4), 453-468.

Wade, R. (1985). What makes a difference in inservice teacher education? A meta-analysis of research. *Educational Leadership, 42*(4), 48-54.

Wanous, D., & Sparks, D. (1981). *Analysis of individualized teacher center services.* San Francisco, CA: Far West Laboratory for Educational Research and Development.

Ward, B., & Tikunoff, W. (1981, September). The relationship between inservice training, organizational structure and school climate. *Inservice,* 7-8.

Watts, H. (1985). When teachers are researchers, teaching improves. *Journal of Staff Development, 6*(2), 118-127.

Westbrook, C., Loomis, A., Coffina, J., Adelberg, J., Brooks, S., & Ellis, S. (1985). Classroom research: A promising model for staff development. *Journal of Staff Development, 6*(2), 128-132.

Wise, A., & Darling-Hammond, L. (1985). *Educational Leadership, 42*(4), 28-33.

Wood, F. (1989). Organizing and managing school-based staff development. In S. Caldwell (Ed.), *Staff development: A handbook of effective practices* (pp. 26-43). Oxford, OH: National Staff Development Council.

Wood, F., & Kleine, P. (1987). *Staff development research and rural schools: A critical appraisal.* Unpublished paper, University of Oklahoma, Norman.

Wood, F., McQuarrie, F., & Thompson, S. (1982). Practitioners and professors agree on effective staff development practices. *Educational Leadership, 43,* 63-66.

Wood, F., Thompson, S., & Russell, F. (1981). Designing effective staff development programs. In B. Dillon-Peterson (Ed.), *Staff development/organization development* (pp. 59-91). Alexandria, VA: Association for Supervision and Curriculum Development.

Wu, P. (1987). Teachers as staff developers: Research, opinions, and cautions. *Journal of Staff Development, 8*(1), 4-6.

Yarger, S., Howey, K., & Joyce, B. (1980). *Inservice teacher education.* Palo Alto, CA: Booksend Laboratory.

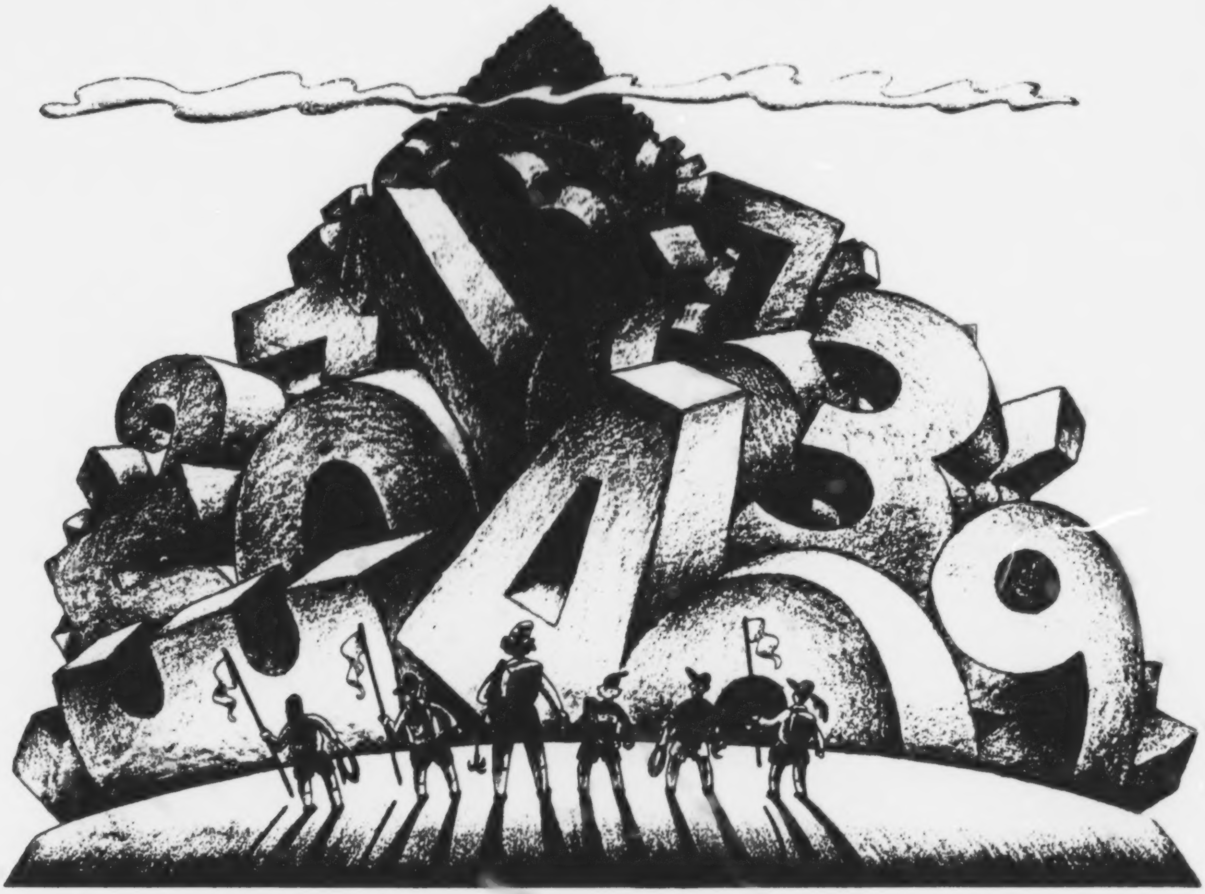
Zeichner, K. (1983). Alternative paradigms of teacher education. *Journal of Teacher Education, 34*(3), 3-9.

Zigarmi, P., Betz, L., & Jensen, D. (1977). Teacher preference in and perceptions of inservice. Educational Leadership, 34, 545-551.

Reprinted with permission of
Far West Laboratory from Far West
Focus on Changing School Practice.
(c) 1993, 1-4.

OCTOBER 1993

FarWest focus
On Changing School Practice



Scaling the Heights
Math Cases Build Learning Communities

After five years of teaching her sixth graders such important but complex mathematics concepts as fractions and percents, Alma Ramirez has concluded that her job isn't actually to *teach* math at all — at least not in the traditional sense of imparting knowledge.

Instead, this Hayward, California middle school teacher sees her role as that of a helpful guide for students in their own idiosyncratic journeys toward mathematical understanding. To do that, she says, a teacher must somehow get inside students' minds, "listening to what kids are thinking and understanding."

INSIDE

*Early Childhood
Transition
Conference*

It wasn't a flash of inspiration that brought Ramirez to this conclusion. Rather it was a slow but exciting process of reflection and inquiry generated by discussions with other teachers about real-life classroom dilemmas, as portrayed in math cases.

Cases Hit Close to Home

Over the past four years, as part of a joint project between the Hayward Unified School District and Far West Laboratory, Ramirez and a small number of her fellow teachers have gotten together once a month to talk about teaching math. Prompting each discussion has been a different math case, a narrative written by an upper elementary or middle school teacher about a personal experience teaching fractions, decimals, ratios or percents — math domains usually considered hard to teach and hard to learn.

Written by "other" teachers, the cases provide a distance that allows teachers free discussion without worry about hurt feelings.

The narratives used in Ramirez's discussion group were developed for the forthcoming FWL casebook, *Dilemmas of Teaching: Math Cases to Promote Inquiry, Discussion and Reflection*, edited by FWL's Carne Barnett along with Donna Goldenstein and Babette Jackson of the Hayward district. As a group, the cases raise questions and pose dilemmas that face math teachers from Provo to Petaluma. A case author is as likely to recount a perceived failure as he is to relate a success. And more often than not, a case hits close to home to someone in the group if not everyone.

"When we look at cases and read what a teacher did or thought, we see many situations where we might have done the same thing ourselves," says Ramirez. "I might have used that same manipulative myself and gotten the same response from my students. So you begin to analyze *why* things happen as they do — why a student might have misunderstood something, for example."

Although it's a "slow process," she says, eventually discussion group teachers start using this same reflection and inquiry method in their classrooms. When deciding how to present a particular concept, they think of different options, consider the pros and cons of each strategy and try to anticipate the potential for misunderstandings. Instead of having a preordained teaching approach for any given concept, the teachers are more likely to adjust their strategies to the circumstances and the individual students in their class.

Ramirez and the others in her discussion group have discovered for themselves something that Stanford education professor and researcher Lee Shulman has long argued: teaching skills are not, as commonly thought, generic to age levels and subject areas. Rather, successful teaching is distinctly different for different subjects, different learners and different settings. More than just a set of learned behaviors, good teaching requires reasoning as well as action, imagination as well as intellect.

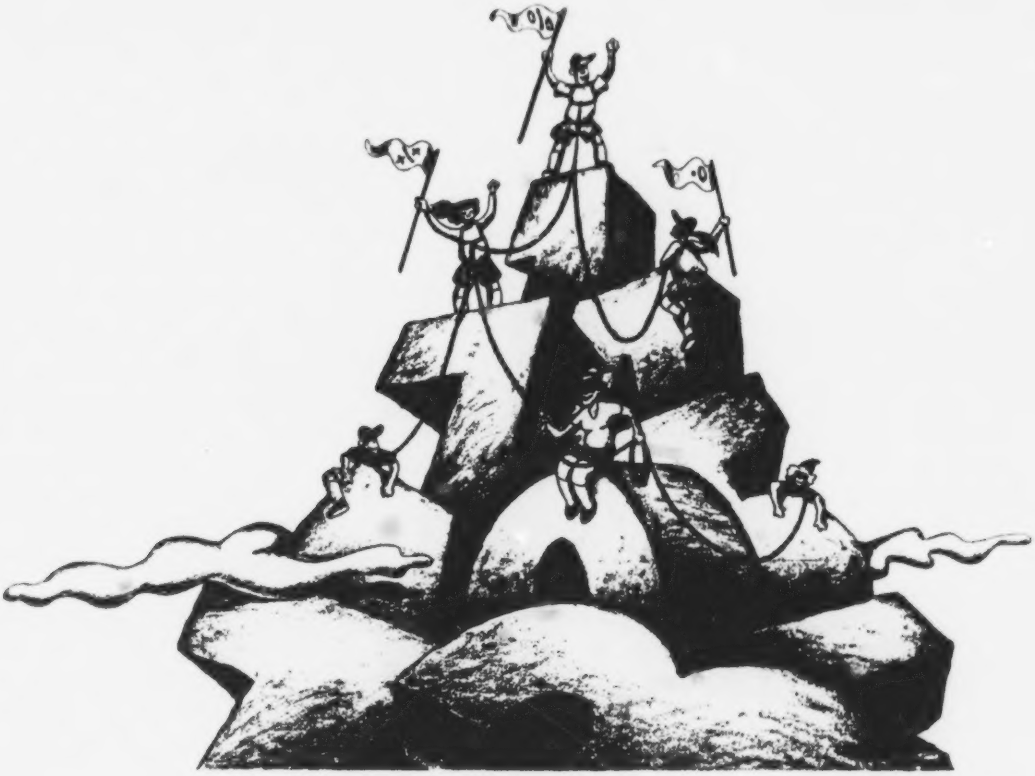
Not Your Average In-Service

In cases discussions, a facilitator tries to focus participants first on clarifying and understanding the problem or problems embedded in a case, then on a consideration and evaluation of alternative solutions. Some cases press participants to identify the philosophic underpinnings of the author's classroom choices and the consequences for learning.

In the casebook preface, teachers from the pilot discussion group note that they had signed on expecting a "traditional math in-service, in which a presenter instructs participants to his philosophy or teaching approach." Instead they got cases and, in the discussions themselves, a mechanism for furthering their own understanding of content and what makes good teaching. And instead of a resident expert, their discussion facilitator served simply as a well-informed guide.

In fact, says editor Carne Barnett, the location of authority, in the discussions and later in the classroom, is one of the biggest changes that comes out of case discussions. "As teachers in the discussion group accept more responsibility for figuring things out, no longer expecting the facilitator to offer the right answer, they become empowered. And once it happens to them, they seem eager to empower their own students."

In this sense, case discussions model both a community of learners and the kind of teacher-student interactions that are grounded in constructivism and endorsed by reform documents such as the National Council of Teachers of Mathematics *Standards*. "The discussion is a process for changing fundamental beliefs about what it really means to teach," says Barnett. "What emerges is the idea that you're



Illustrations by Pablo Haz

not just trying to get kids to understand something, but to actually think for themselves."

Teachers who have become comfortable discussing important teaching issues in a formal group are likely to continue such exchanges informally. When a question or classroom challenge arises down the road, they're more likely to draw on the teacher across the hall, says Ramirez. Sharing insights, theories, questions and sometimes even insecurities with colleagues develops into a welcome habit.

Discussions also help them recognize that student misunderstanding can be a valuable teaching tool, not just through the case discussions, but in the classroom. The next time one of their students comes up with a wrong solution, these teachers are more likely to explore the child's thought process rather than automatically and immediately searching out a child who has the "right" answer. Understanding why a student has "gotten stuck" can enhance the learning experience for everyone, teacher included.

And as these teachers come to rely more on discussion with each other to enhance their understanding of issues and concepts, they begin to see the value of encouraging students to learn from each other as well, rather than interacting solely with the teacher.

Cases Cover Pedagogy and Content

In addition to raising issues specifically relevant to the teaching of math, each of the 29 cases raises a broad teaching issue relevant to any content area. For example, one case prompts discussion about two opposing points of view. Should a teacher introduce ambiguous material that might confuse students yet help them recognize the complexity of a particular concept? Or, instead, should a teacher strive always to make things as simple and clearcut as possible for young learners and in doing so, risk disguising the true complexity of a concept?

At the same time, a case's math-specific issues may challenge and ultimately enhance discussants' own mathematical understanding. For example, in one case a student asks, "How can 100 percent of something be just one thing?" The very question can give a teacher pause, says Barnett. "Although most of us would agree that 100 percent means the whole thing or 'one,' the concept can be confusing. If you get 100 percent on an exam, do you get a 1? If you poll 23 people and 100 percent respond that they like toothpaste, does 100 percent mean 23 or 1?

"What seems obvious on the surface is really quite complex when you're trying to promote understanding of a concept and not just memorization of a rule. As a teacher you have to understand the subtleties of mathematics — that 23 out of 23 is 1 or 100 percent while 100 percent of 23 people is 23."

Raising Consciousness

While all cases raise important issues, some raise consciousness as well, prompting discussants to rethink attitudes and expectations. The "how can 100 percent be just one thing" case grew out of the author's use of a multiple choice problem that asked students to decide whether 100 percent equalled 10, 1, 100 or 1/100. The teacher had decided to use what some discussants viewed as a "trick" question because she was preparing them for a math contest in which such problems were sure to appear.

> **A teacher must be able to see mathematics through the child's eyes and know what instructional experiences can be used to capitalize on that child's thinking.**

Barnett, who served as discussion facilitator for Ramirez's group, says the case raised issues of social justice and self-esteem. Some teachers expressed reluctance at giving their students a problem that might "set them up" to make errors and potentially endanger student self-esteem. But others pointed out that students from more affluent neighborhoods would certainly be given this type of problem because it's typical of the type found on college entrance exams. Were these teachers doing students an injustice by not also preparing them for this type of exam?

Seeing Math Through a Child's Eyes

It's been said that great teaching is the merging of masterful pedagogy — the process of teaching — and deep knowledge of the subject matter. Math case discussions help participants refine and build on both pedagogical knowledge and content knowledge, thereby increasing teacher confidence and effectiveness. The results from pre- and post-discussion tests given to case discussants suggest a statistically significant improvement in their content knowledge.

But equally important, says Barnett, is the expansion of pedagogical content knowledge, which she defines as "being able to see the mathematics through the child's eyes and know what instructional experiences can be used to capitalize on that child's thinking.

"Pedagogical content knowledge is knowing how particular concrete materials relate to the abstract mathematics. It's being able to know and anticipate how students may misunderstand. It's understanding not just the mathematics, but how to represent the *idea* of multiplication — how to deal with the language of that idea. That's all pedagogical content knowledge."

Cases Encourage Collaborative Reflection

Historically, neither this knowledge nor the inquiry skills necessary to acquire it have been adequately addressed in standard teacher education classes. "I was a teacher educator for a long time and we always tried to get students to reflect," says Barnett. "We thought maybe they needed more classroom experience to be better reflectors. But even when observing in a classroom, they don't see half of what's going on.

"They tend to focus on management issues, like a kid dropping his pencil on the floor and the teacher saying if he drops it again he's going to the office. Yet that same student teacher can observe a math class all day long and never recognize the multiple opportunities for student misunderstanding."

After years of wondering how teachers could become better reflectors, Barnett turned to case discussions as a forum for collaborative reflection.

"Everybody in the group is looking at the same experience or piece of information," she says. "So what you get is everybody's input into what they see, what the situation means and, most important, how to change the situation to help a child learn."

— *Joy Zimmerman*

Dilemmas of Teaching: Math Cases to Promote Inquiry, Discussion and Reflection and a facilitator guide will be available late Spring 1994 (price not yet available). For information or to order from the publisher, Heinemann, call 1-800-541-2086; fax 603-431-7840; or write 361 Hanover St., Portsmouth, NH 03801-3912.

BEST COPY AVAILABLE

Reprinted with permission from "The
Mathematics Curriculum and Teaching
Program: Guidelines for Consultants and
Curriculum Leaders," Curriculum Corporation,
141 Rathdown St., Carlton 3053 Victoria
Australia. Tel: 011 61 3 639 0699
Fax: 011 61 3 639 1616

The Mathematics Curriculum and Teaching Program

Professional development package

Guidelines for consultants and curriculum leaders

John Owen, Neville Johnson, Doug Clarke,
Charles Lovitt, Will Morony

Assisting teachers, consultants and systems to explore new educational territory by providing:

- documented classroom images of that new territory,
- professional development structures to facilitate the exploration.

Overview of the MCTP professional development models

Having outlined three stages within which teachers might consider the incorporation of new approaches and summarised the variability in teachers' readiness for change, just how do schools and school support personnel operate in practice to encourage the uptake of new skills and understandings?

An important part of the response lies in the establishment of a comprehensive professional development program.

The question is: how can this be encouraged by those responsible for planning, developing and implementing school mathematics curriculum policy; and by consultants with a brief to support teachers in this task?

Part of the answer is that there are a number of approaches or models by which teachers might be assisted and in which consultants might operate. The models are a synthesis of good professional development practice drawn from theoretical perspectives and practical experience: the best we have been able to find operating across the country.

The models are a synthesis of good professional development practice drawn from theoretical perspectives and practical experience ...

At the outset, we would like to point out that the 'one-shot' inservice is not included as one of the models. This approach is in conflict with many established principles of professional development. We do not recommend this approach, as it is unlikely to lead to lasting change.

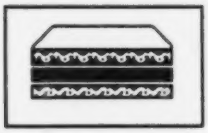
On the following pages, we describe briefly each of eight models as a basis for selecting between the approaches.

As part of a professional development program, teachers workshop the activity Tell me a story. (Activity Bank, Vol. 1, *page 247*)

Structured Course

Here many of the processes are formalised into an organised course over a fixed time frame, perhaps a ten week period. Teachers commit themselves, (hopefully with school support in the form of regular time release from school responsibilities) to attend sessions, and to incorporate course content into their classroom practice. Discussion of themes and the results of trials and developments which teachers undertake in their classrooms between sessions, form the basis of the sessions.

The roles of the consultant/curriculum leaders are to organise the course and to arrange for and/or participate in the presentation or sharing of new approaches with teachers.



Sandwich Course

This generally consists of two sessions, between which school level trials of themes presented in the first session are 'sandwiched'. These are discussed at the second session. Because of the relatively short time span of the model, the emphasis is on the initial trialling stage.

Broadly, the roles of the consultant/curriculum leader are to organise the course and to arrange for and/or participate in the presentation of new approaches to teachers.

The sandwich model is an attempt to make a small but important extension beyond the limitations of the 'one-shot' inservice. Specifically it aims to build in classroom trialling and a structured opportunity for reflection.

In-school Intensive

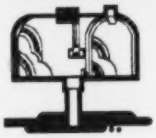
This model is conducted within a school with a group of staff, preferably the whole of the mathematics staff. The consultant /curriculum leader develops a plan with the staff, to which they make a commitment over a given period. Depending on the length of this commitment the staff may consider all three stages; namely initial trialling, implementation and continuation.

The roles of the consultant/curriculum leader are to support a school to become involved, to facilitate a program for the school, and to arrange and/or provide presentations of illustrative classroom practice when necessary.

School Cluster Groups

Groups of schools form a network to consider new approaches. The group provides feedback to each other on the trials via regular group meetings of staff drawn from the cluster. Progression through the stages depends on the life of the cluster and the preferences of the cluster members.

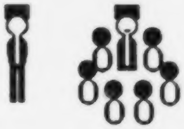
Broadly, the roles of the consultant/curriculum leader are to set up and provide maintenance activities for the group, and to arrange for and/or provide presentations when necessary.



Postal Model

Teachers receive and trial new materials through the post and comprehensive feedback is provided to a central or regional consultant who is responsible for the mailing. This model is designed to support teachers in remote regions to try new strategies and to reflect on their effectiveness.. The consultant may assist in organising occasional sharing sessions for teachers if these are possible.

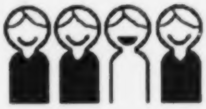
The roles of the consultant/curriculum leader are to keep in touch with the teachers concerned, and to arrange for and/or provide presentations if sessions are possible.



Pre-service Model

Using arrangements in pre-service teacher education, student teachers trial a small number of activities while in schools, and in conjunction with supervising teachers and lecturers they analyse the impact of the approaches. In this way preservice teachers can be exposed to a range of new ideas by using the best creations of experienced teachers.

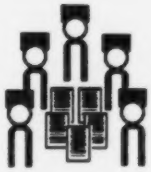
Broadly, the role of the consultant/curriculum leader is to liaise with teacher education institutions and encourage them to use the model.



Peer Tutoring

This relies on the availability of a colleague within the school to provide support for the use and incorporation of new approaches. Effective use of peer tutoring requires the systematic collection of data about teaching activities and the non-threatening support of a 'critical friend.'

The role of the consultant/curriculum leader is to encourage groups of teachers to use the approach if appropriate, inform them of its characteristics and provide input about new approaches as a basis for their deliberations.



Activity Documentation

This involves the creation of networks of teachers who have progressed in the use of new approaches, perhaps to the implementation and continuation stages. The networks are designed to gather and share the documents and activities so developed.

Broadly, the roles of the consultant/curriculum leader are to set up the networks and maintain them.

Structured Course

Structured course in a nutshell

- Fixed time frame (say ten weeks).
- Course covers range of selected themes/issues (say four or five themes).
- Regular sessions at central location (say two hours a week).
- Support visits by consultants to school between sessions.
- A typical session
  - — short introductory activity
  - — reflections on trialling
  - — discussion of theory, readings on current theme
  - — workshopping illustrative activities
  - — planning classroom trialling.
- Suitable for accreditation at a tertiary institution.

Role of consultant/curriculum leader

INITIAL TRIALLING	IMPLEMENTATION	CONTINUATION
• workshop the new approaches with participants	• encouraging teachers to create and document their own activities	• encouraging teachers to write unit outlines
• arrangements by which an 'outside consultant' or participant can demonstrate new approaches	• encouraging teacher to trial these new activities in their schools	• hosting feedback on these tasks
• provide theoretical support for new approaches	• hosting feedback sessions on these activities	
• building a commitment among participants to try activities in their schools		
• linking the need for the approach to the existing views of the teacher.		

Logistics — What to look for when making the arrangements

- Provide a coherent total program; sessions must be linked over the life of the course.
- Arrange teacher-release if possible.
- Encourage cooperation between teachers in the course.
- Assist teachers to monitor their own progress.
- Invite 'outside consultants' to suitable sessions.
- Arrange for publicity about the course and its outcomes.
- Place emphasis on initial trialling and to some extent on implementation. Emphasis on implementation /continuation phases depends on length of course.

Sandwich Course

Sandwich Course in a nutshell

- Two seminar sessions, two to three weeks apart.
- Classroom trialling 'sandwiched' between these.
- Usually focus on only one selected theme.
- Session one workshops illustrative activities on this theme.
- Session two reflects on classroom trialling and brainstorms further actions at school level.

Role of consultant/curriculum leader

If sufficient seminar times are available, all stages could be treated. However, in many cases there will only be two or three seminars. In these cases, the consultant/curriculum leader needs to concentrate on the initial trialling stage.

INITIAL TRIALLING	IMPLEMENTATION	CONTINUATION
• workshop of the new approaches with the participants	• encouraging teachers to write activities in sessions	• encouraging teachers to write unit outlines
• arrangements by which an 'outside consultant' or participant teacher can demonstrate new approaches	• encouraging teachers to trial sessions in their schools	• hosting feedback on these tasks
• building a commitment among participants to try activities in their schools	• hosting feedback sessions on these activities	
• linking the need for the approach to the existing views of the teacher.		

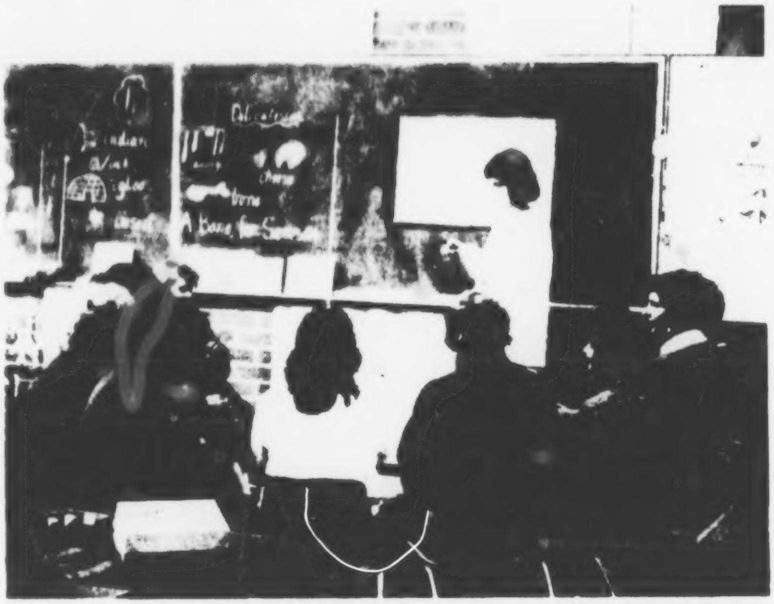
Logistics — What to look for when making the arrangements

- Initial focus is on supporting individual teachers.
- Emphasis is placed on initial trialling.
- Implementation left mainly to the teachers.
- Time between seminars must allow for school trials.

In-school Intensive

In-school Intensive in a nutshell

- Focus is entirely on needs of one school.
- Faculty meeting determines issues to be explored and action planned.
- Action plan might include:
  - — classroom demonstration of illustrative activities
  - — discussion and subsequent trialling by all faculty members
  - — feedback and evaluation from trialling.
- Brainstorm about long-term continuation.
- Emphasis on a key group of staff supporting one another.



Role of consultant/curriculum leader

INITIAL TRIALLING	IMPLEMENTATION	CONTINUATION
• workshop the new approaches with participants	•encouraging teachers to create and document their own activities	• encouraging teachers to write unit outlines
• arrangements by which an 'outside consultant' or local teacher can demonstrate new approaches	•encouraging teachers to trial these new activities in their own classrooms	• hosting feedback on these tasks
• building a commitment among participants to try activities in their own classrooms	• hosting feedback sessions on these activities	
• linking the need for the approach to the existing views of the teacher.		

Logistics — What to look for when making the arrangements

- Negotiate with the teachers the focus of the activities.
- Assist teachers to prepare a plan of action for implementation and evaluation.
- Help the group of staff work together to initiate action — act as critical friend.

Postal Model

Postal Model in a nutshell

- Teachers receive trial materials through the mail.
- Written feedback forms are completed and returned to the consultant.
- Particularly useful in remote areas.
- Occasional sharing days.

Role of consultant/curriculum leader

If occasional sharing sessions are held

INITIAL TRIALLING	IMPLEMENTATION	CONTINUATION
• workshop of the new approaches to participants	• encouraging teachers to create and document their own activities	• encouraging teachers to write unit outlines
• arrangements by which an 'outside consultant' or participant can demonstrate new approaches	• encouraging teachers to trial these new their schools	• hosting feedback on on these tasks
• building a commitment among participants to try activities in their schools	• hosting feedback sessions on these activities	
• linking the need for the approach to the existing views of the teacher.		

Logistics — What to look for when making the arrangements

- Meetings if possible should be at beginning of the process and crucial for initial trialling phase.
- Use of tele-conferencing and other linking technologies should be investigated.

If no initial meeting

INITIAL TRIALLING	IMPLEMENTATION	CONTINUATION
• sending most materials and guidelines for use through the mail	• encouraging teachers to create and document and trial them in the schools	• encouraging teachers to write units for their schools
• assisting teachers to trial the units through telephone computer, video, facsimile or mail links	• assisting teachers to link these activities through telephone computer, video, facsimile or mail links	• assisting teachers to refine their units through telephone or computer, video, facsimile or mail links

Pre-service Model

Pre-service Model in a nutshell

- Pre-service students workshop new approaches at college.
- Following allocation of topics on teaching rounds, students and tutors jointly select MCTP activities for trialling.
- Selected activities are trialled during rounds.
- Feedback sheet is completed by student and supervising teacher.
- Students share experiences in tutorials at college.

Role of consultant/curriculum leader

INITIAL TRIALLING	IMPLEMENTATION	CONTINUATION
• encourage pre-service institutions to consider approaches in MCTP Bank	• encourage staff of institution to have students write new units for the trialling and sharing	
• collect information about the logistics and forms of the program and circulate it to interested institution		
• assist institutions to obtain MCTP resources		
• follow-up supervising teachers in the schools to help assess impact and possible interest		
• support interested teachers as required		

Logistics — What to look for when making the arrangements

- The consultant/curriculum leader links the MCTP project with the staff of pre-service teacher education institutions.
- Emphasis is placed on facilitating initial trialling by the education staff, pre-service students and supervising teachers.

Peer Tutoring

Peer Tutoring model in a nutshell

- Teacher and trusted colleague observe each other in action
- Meetings to discuss observations
- Planning subsequent action
- Further classroom trialling and observation.

Role of consultant/curriculum leader

INITIAL TRIALLING	IMPLEMENTATION	CONTINUATION
• demonstration of the new approaches with participants	• encouraging teachers to create and document their own activities	• encouraging teachers to write unit outlines
• building a commitment among participants to try activities in their schools	• encouraging teachers to trial these new activities in their schools	• hosting feedback on on these tasks
• linking the need for the approach to the existing views of the teachers.	• hosting feedback sessions on these activities	
• responding to the invitation from teachers to be a 'critical friend' during initial use of MCTP activities	• responding to the invitation from teachers to be a 'critical friend' during use of teacher-made activities	• responding to the invitation from teachers to be a 'critical friend' during unit writing
• choosing the appropriate time and occasion to present information and demonstrate new approaches if desired		
• help teachers use the cyclical process of peer tutoring		
• facilitate arrangements (e.g. time-release) for teachers to work together		

Logistics — What to look for when making the arrangements

- The consultant/curriculum leader relies on the teacher to request information on the innovation before intervening.
- The skill of process consultancy related to improving interpersonal procedures is particularly relevant (for example, communication skills, problem solving and action planning strategies).

Activity Documentation

Activity documentation in a nutshell

- Teachers bring notes and equipment for one activity that has resulted in personal success in their school.
- These activities are workshopped with small groups.
- Teachers undertake to trial at least two of the activities they have experienced during the day.
- Between-session trialling occurs.
- Second meeting is devoted to formal documentation of activities following trialling.
- These are circulated to total group and interested others.

Role of consultant/curriculum leader

Logistics — What to look for when making the arrangements

- Consultant/curriculum leader needs facilities to store and update information.
- Support personnel act as a postman in the dissemination of ideas and materials from teacher to teacher/school to school.
- Assumption is that initial trialling has already taken place (perhaps through the use of one of the other models).
- Consultant/curriculum leader must be seen to match needs of teachers with available information from other teacher sources.
- Use of technologies such as facsimile to quickly share documents.

IMPLEMENTATION	CONTINUATION
• facilitating transfer of activities and their use from school to school	• facilitating transfer of units and feedback reports from school to school
• building up a central bank of good activities	• building up a central bank of good units

11

PLANNING AND IMPLEMENTING PROFESSIONAL DEVELOPMENT

Audience:

- Individuals responsible for planning and implementing professional development for science and mathematics educators at the building, district, regional, or state level.

Desired Outcomes for Participants:

- To identify and apply several approaches to gathering information on needs.
- To develop a checklist for managing and organizing training events.
- To use a variety of planning tools to design long-term, comprehensive professional development for systemic change.

Materials:

- **Transparencies:**
  - *Think-Pair-Share* (B-7-3)
  - *Questions about Needs Assessment* (11-8)
  - *Reasons for Assessing Participant Needs* (11-9)
  - *Determining a Focus for Professional Development* (11-10)
  - *Determining a Focus: Process Points* (11-11)
  - *Summary of Best Practices in Needs Assessment* (11-12)
  - *Four Techniques for Needs Assessment* (11-13)
  - *Flow of Jigsaw* (11-14)
  - *Designing Effective, Long-Term Professional Development: Introductory Activity* (11-15)
  - *Framework for Designing Effective Professional Development* (11-16)
  - *Thinking Across the Curriculum* (11-17 and 11-18)
  - *The Change Agent's Role: Think-Pair-Share* (11-19)
  - *Change Agentry* (11-20)
  - *Contexts for Planning* (11-21)
  - *Alternative Formats and Approaches* (11-22)
- **Handouts:**
  - *Determining a Focus for Professional Development* (11-23 through 11-27)
  - *Summary of Best Practices in Needs Assessment* (11-28)
  - *Four Techniques for Needs Assessment* (11-29 through 11-36)
  - *Case Studies #1-4* (11-37 through 11-40)
  - *Managing Tips for Enhancing Success of Training* (11-41 through 11-44)

- *A Checklist for Planning a Professional Development Program* (11-45 through 11-47)
- *Framework for Designing Effective Professional Development* (11-48 through 11-62)
  - *Focusing On and Clarifying the Change* (11-49)
  - *Developing an Understanding of the Change* (11-50 and 11-51)
  - *Thinking Across the Curriculum . . . Integrating Problem Solving and Critical Thinking Models* (11-52 and 11-53)
  - *The Change Agent's Role: Think-Pair-Share* (11-54)
  - *Change Agentry* (11-55)
  - *Contexts for Planning* (11-56)
  - *Creating a Plan for Change* (11-57 and 11-58)
  - *Alternative Formats and Approaches* (11-59)
  - *Carrying Out the Change Plan* (11-60)
  - *Looking Back on the Design* (11-61 and 11-62)

- Overhead projector, screen, and overhead pens
- Newsprint, easels, tape, and markers

Time Required: Five to six hours

Facilitator's Notes: All professional development situations are different. They depend on the participants' goals, available resources, and the context. Yet they have two things in common: they must address the needs of participants and they must be well designed and implemented. This activity provides participants with some tools and opportunities to improve the professional development experiences they sponsor.

Process: NEEDS ASSESSMENT

1. Provide an overview for the activity, saying that participants will explore strategies for needs assessment, planning, and managing a wide range of professional development efforts. Begin with needs assessment. Using the **Think-Pair-Share (B-7-3)** transparency from **Appendix B-7**, explain the process. Place the **Questions about Needs Assessment (11-8)** transparency on the overhead. Ask participants to first THINK about the questions on their own and jot down a few ideas. After a minute or so have them PAIR and SHARE their responses.

2. Ask for a few responses to each question. Use the **Reasons for Assessing Participant Needs (11-9)** transparency to explain why needs assessments are important.

   Explain that needs assessment often falls short of achieving all these purposes for a number of reasons, some of which they have already noted. First, quick-and-dirty instruments sometimes result in a wish list that can never be fulfilled and usually represent "wants" rather than deep-felt needs. Second, information is typically collected only from potential participants and usually focuses on their individual needs rather than those of their students, schools, etc. The result is one more activity that is not systemic, in that it doesn't connect with the goals, needs, or context of the organizations in which participants work.

   The approach included in this *Toolkit* is broad-based, both in what information is considered and from whom it is gathered. The process of needs assessment is also considered important: who is involved at each step and how. The assumption is that, the more involvement, the more initial understanding and commitment to the learning opportunities results.

3. Distribute the handout **Determining a Focus for Professional Development (11-23 through 11-27)** and use the corresponding transparency **(11-10)** to describe how school or district staff can participate in needs assessment and priority setting in an effort to focus professional development. The purpose is to get a fix on more than just needs, and more than just from the participants' perspectives. It is more than an effort focused on individuals. Therefore, it calls for an investment of time on the part of a cross-role team, representing those who will participate in the actual development activity(ies). The team becomes responsible for the design, implementation, analysis, and reporting of assessment information, as well as determining what the results say for professional development priorities.

   Ask participants to form groups of four; assign each group member two steps from the handout. Use the **Determining a Focus: Process Points (11-11)** transparency to suggest points for discussion. When they have finished reading, ask them to think about (1) the key points of each step and (2) how each step has been handled in their school, district, etc. with respect to science and/or mathematics. When everyone in the group is finished reading and thinking, have them report out to their group. Ask them to discuss: Which of the considerations are most often overlooked? Which are the most difficult to carry out? Which are the most important?

Reconvene as a large group and have groups report the highlights of their discussions. Ask: How could you improve needs assessment?

4. Distribute the handouts **Summary of Best Practices in Needs Assessment (11-28)** and **Four Techniques for Needs Assessment (11-29 through 11-36)** and using the **Summary of Best Practices in Needs Assessment (11-12)** and **Four Techniques for Needs Assessment (11-13)** transparencies, discuss briefly.

   Explain that the group will use these exercises to practice application of the needs assessment tools, especially the techniques for gathering information. Distribute the handout **Case Studies #1-4 (11-37 through 11-40)**.

   Explain the jigsaw technique (see **Appendix B-3**) and using the **Flow of Jigsaw (11-14)** transparency, explain the process for this exercise. Each home team member will study a different case illustrating a situation science and mathematics leaders may find themselves in.

   Conduct the jigsaw. Allow 45 minutes.

PLANNING FOR SMALL-SCALE PROFESSIONAL DEVELOPMENT

5. Tell the participants they will now consider how to plan and organize the best possible professional development experiences. First, they will design a training session. Divide the group again into different groups of four. Give each group some newsprint and assign one of these questions; have them brainstorm responses:

   - What do you need to do to *design* a training session?
   - What do you need to do *before* the training session begins?
   - What do you need to do *during* or *throughout* a training session?
   - What do you need to do *after* a training session?

   Allow 15 minutes.

   Distribute the handout **Managing Tips for Enhancing Success of Training (11-41 through 11-44)** and ask each group to add those tips or activities they identified that are not on the handout. Ask each group to report their additions.

460

PLANNING FOR LONG-TERM PROFESSIONAL DEVELOPMENT

6. Explain that in order to facilitate more complex, systemic change in science and mathematics education and to design long-term professional development, comprehensive checklists, frameworks, and planning tools are helpful. The next two exercises present:

   - a checklist for planning a professional development program; and

   - a more comprehensive framework for designing effective, long-term professional development.

7. Distribute the handout **A Checklist for Planning a Professional Development Program (11-45 through 11-47)**. Ask participants to think about these questions with respect to professional development for science and mathematics:

   - Which of the considerations are most often overlooked?

   - Which are the most difficult to carry out?

   - Which are the most important?

   Share ideas in whole group or small group discussions.

   (Optional) You may want to do an application exercise before or instead of moving on to more step-by-step, long-term professional development planning. Ask participants to refer back to the needs assessment case studies.

   Assign each small group one case study to talk about how they might use this checklist and the learnings of Activities 8, 9, and 10 to design a science or mathematics professional development activity. After 20 minutes, have small groups report out.

8. Explain that the group will now be introduced to a framework for designing comprehensive professional development and will use it to design plans for their own current projects, problems, or innovations in science and mathematics.

   Display the **Designing Effective, Long-Term Professional Development: Introductory Activity (11-15)** transparency and ask participants to think about their biggest challenge as they design long-term professional development. Give them some examples (e.g., participants may have very different needs; your efforts might be competing with others; there may be limited resources, support, or time). Give each person a piece of newsprint and marking pens. Allow 15 minutes to depict their "design challenge." Ask each person to take two to three minutes to share his or her "design challenge" with the whole group. Ask: What are some common themes across these design challenges?

9. Distribute the full handout **Framework for Designing Effective Professional Development (11-48 through 11-62)** and display the **Framework for Designing Effective Professional Development (11-16)** transparency. Referring to the set of handouts, describe their use in the design process. Explain that they will be using an "inquiry process" to ask themselves questions about parts of the planning and design process (these relate to the puzzle pieces).

10. Use the **Framework for Designing Effective Professional Development (11-16)** transparency to point to the central element in a design of professional development: the change. Ask participants to turn to **Focusing On and Clarifying the Change (11-49)** and, working in groups of four (or in existing teams), talk through the questions for each of their situations.

11. Use the framework transparency **(11-16)** to point to the next element: understanding. Show the **Thinking Across the Curriculum (11-17 and 11-18)** transparencies to make connections to instruction. Ask the groups to discuss the questions on the handouts **Developing an Understanding of the Change (11-50 and 11-51)** and **Thinking Across the Curriculum . . . Integrating Problem Solving and Critical Thinking Models (11-52 and 11-53)** for each of their situations.

12. Explain that for the next activity participants will be using the Think-Pair-Share technique (see **Appendix B-7**). Place **The Change Agent's Role: Think-Pair-Share (11-19)** transparency on the overhead and ask participants to THINK about the three questions. Ask the group to turn to the handout **The Change Agent's Role: Think-Pair-Share (11-54)** and ask them to share their thoughts with a partner (PAIR), and then SHARE with whole group. Ask:

    - What do effective change agents and designers of professional development need to know in order to facilitate understanding?

13. Create the change agentry puzzle together. Use the **Change Agentry (11-20)** transparency and refer to the handout **Change Agentry (11-54)**; ask the large group for general arenas of learning to place in each of the blank puzzle pieces (e.g., CBAM, adult development,

462

collaboration/team building). Refer to other activities in Section IV as ways to explore these areas. Ask:

- In what ways does greater understanding refine or refocus the change?

14. Use the framework transparency **(11-16)** to point to another element: planning. Use the **Contexts for Planning (11-21)** transparency and refer to the handout **Contexts for Planning (11-56)** to talk about what's appropriate for different levels. Ask participants to turn to the handout **Creating a Plan for Change (11-57 and 11-58)**. Ask the groups to discuss the questions for each of their situations.

    Reconvene the large group to report highlights and issues raised in their discussions. Use the **Alternative Formats and Approaches (11-22)** transparency to generate an array of alternatives.

15. Use the framework transparency **(11-16)** to point to another element: carrying out. Refer participants to the handout **Carrying Out the Change Plan (11-60)** and note that this will be used in follow-up during implementation. Ask the groups to discuss the questions.

    Ask the groups to report out highlights of their discussions or questions for further discussion.

16. Use the framework transparency **(11-16)** to point out the last piece: looking back. Refer participants to **Looking Back on the Design (11-61 and 11-62)** and ask them to discuss the questions in their groups.

    Reconvene the large group to report highlights and issues raised in their discussions.

17. Ask participants to look back at their definitions of systemic change from **Activity 1: Framing the Dialogue Around Systemic Change**. Ask:

    - How do our discussions of assessing needs and designing professional development feed into the concept of systemic change in science and mathematics?
    - Is there anything about your definition that you would change based on our discussions?

QUESTIONS ABOUT NEEDS ASSESSMENT

1. What kinds of needs assessments have you seen or used in the past?

2. In what ways were they valuable?

3. In what ways were they not? What could have made them more so?

REASONS FOR ASSESSING PARTICIPANT NEEDS

1. To review assumptions about participants' needs and reinforce or modify these as indicated

2. To select topics, materials, and examples that will make the activity relevant and useful to participants

3. To enhance participation

4. To encourage participants to persist, learn, and apply what they learn

DETERMINING A FOCUS FOR PROFESSIONAL DEVELOPMENT

1. Establish a trusting climate.
2. Determine who is responsible and the parameters of the task.
3. Decide on a focus and information needed.
4. Decide how to collect the information.
5. Collect the information.
6. Analyze and synthesize the information.
7. Define the needs and identify improvement goals.
8. Disseminate results.

Source: *Building Systems for Professional Growth: An Action Guide* by Margaret A. Arbuckle and Lynn B. Murray. Andover, MA: The Regional Laboratory for Educational Improvement of the Northeast and Islands. ©1989, 5-10 through 5-14.

DETERMINING A FOCUS: PROCESS POINTS

1. After reading about your two steps, reflect and make notes about:
    - key points for each step
    - how they have been done in your setting.
2. Dialogue with your group about your insights.
3. Discuss:
    - ■ Which of the eight steps are most often overlooked?
    - ■ Which are the most difficult to carry out?
    - ■ Which are the most important?

SUMMARY OF BEST PRACTICES IN NEEDS ASSESSMENT

1. Make it a conscious public activity.
2. Conduct it as an ongoing process.
3. Give importance to staff perceptions of needs.
4. Individualize by building or department.
5. Gather information from various sources using various techniques.
6. Analyze strengths.
7. Relate program to needs assessment information.

Source: Adapted from "Needs Assessment for Inservice Education: Building Local Programs," National Inservice Network. ©1980.

FOUR TECHNIQUES FOR NEEDS ASSESSMENT

1. Interviews
2. Questionnaires/surveys
3. Observations
4. Archival material

FLOW OF JIGSAW

1. Home group members each choose a case (1-4).
2. Assemble in expert groups for each case.
3. Read your case and discuss (20 minutes):
    - How would you design a needs assessment? Who? What? How? When?
    - What techniques would you use to collect data? Why?
4. Reassemble in home groups.
5. Describe your case and points from the discussion (5 minutes each).
6. Discuss (20 minutes):
    - Which of these cases represent your reality?
    - What others could you describe (cases and solutions)?
    - What do you want to try "back home"?
7. Report out.

DESIGNING EFFECTIVE, LONG-TERM PROFESSIONAL DEVELOPMENT:

INTRODUCTORY ACTIVITY

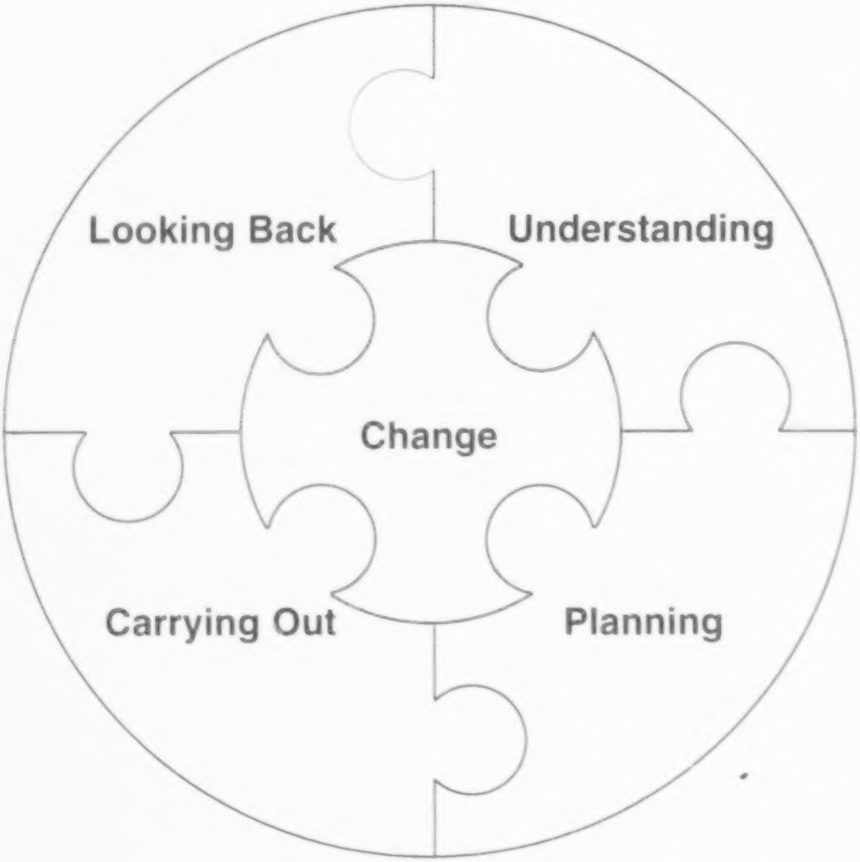
1. Reflect: What is your current science or mathematics professional development "design challenge?" Why is it challenging?

2. Depict it on newsprint.

3. Share your design challenge with the whole group in two to three minutes.

4. Discuss: What common themes do you observe?

FRAMEWORK FOR DESIGNING EFFECTIVE PROFESSIONAL DEVELOPMENT


Looking Back
Understanding
Change
Carrying Out
Planning

Source: "Framework for Designing Effective Professional Development: Change-Based Inquiry Process" by Cathy Cook and Claudette Rasmussen. Oak Brook, IL: North Central Regional Educational Laboratory. ©1994.

THINKING ACROSS THE CURRICULUM

	PHASES		
	BEFORE	**DURING**	**AFTER**
MATH Polya's Thinking Phases	Understand Plan	Carry out	Reflect back
READING KW(H)L	Examine what you **KNOW** Determine what you **WANT** to know and **HOW** you will find out	**READ** the material	**REFLECT** on what you learned
SCIENCE Scientific Method	Determine a researchable question Develop a procedure and identify materials	Conduct the experiment; record the results	Draw conclusions and compare to hypothesis
WRITING Process Writing	Determine context, topic, audience Prewrite	Write	Share . . . present, publish

Source: Adapted with permission of North Central Regional Educational Laboratory from *Problem Solving and Critical Thinking in Mathematics* by Cathy Cook and Claudette Rasmussen. ©1990, revised 1994.

THINKING ACROSS THE CURRICULUM (continued)

	PHASES		
	BEFORE	**DURING**	**AFTER**
CONSTRUCT MEANING	Assess/activate prior knowledge Develop vocabulary Establish a purpose for reading Clarify misconceptions	Select and organize important information Monitor and evaluate information	Reflect and integrate prior knowledge with new understandings Summarize and synthesize what has been learned
STUDY SKILLS The 4Cs	Clarify the learning situation Construct a learning strategy	Carry out the strategy	Check results
CREATIVE DECISION-MAKING PROCESS	Recognize and define the problem Plan tentative conclusions	Test tentative conclusions	Evaluate

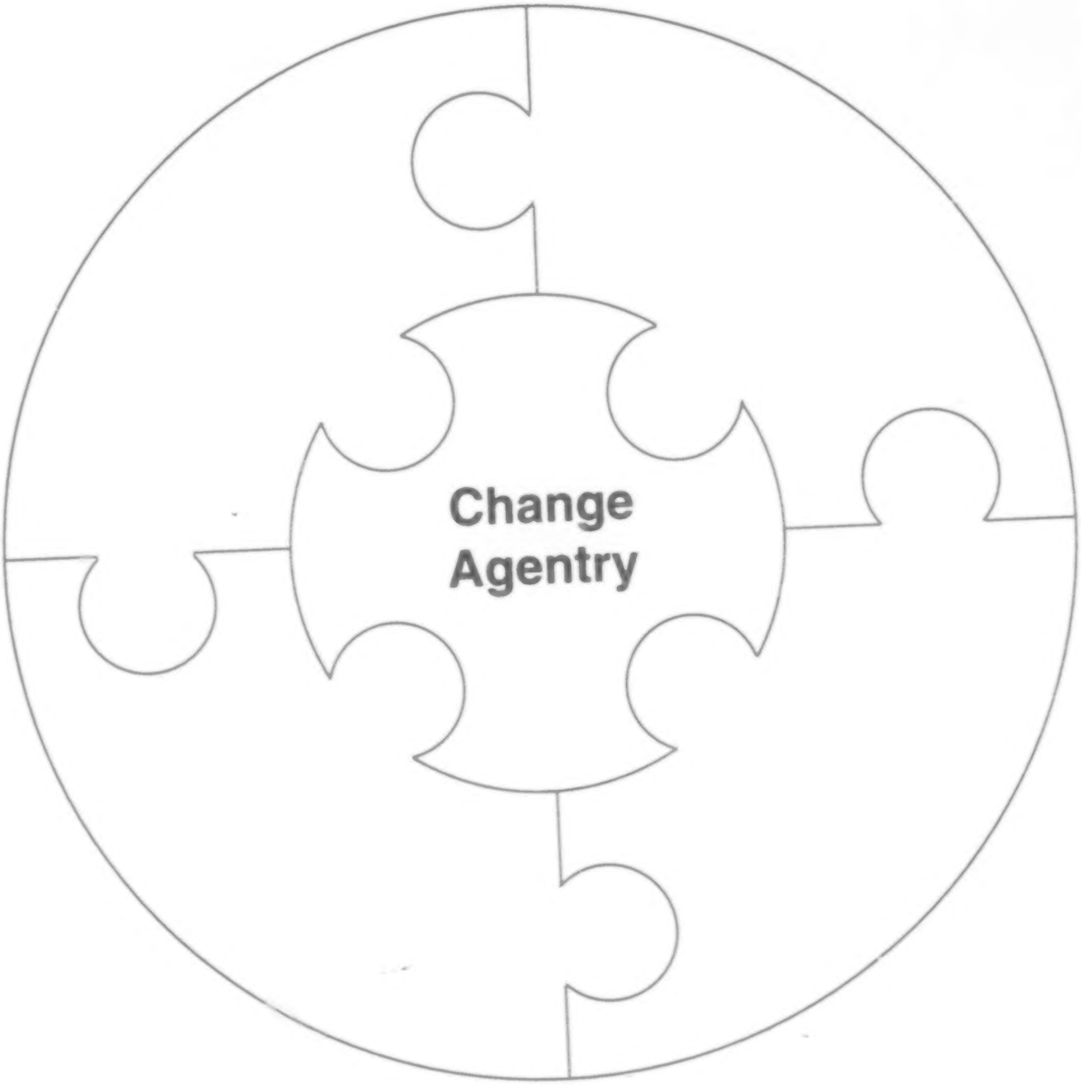
THE CHANGE AGENT'S ROLE:
THINK-PAIR-SHARE

1. How would you describe your role as a change agent?

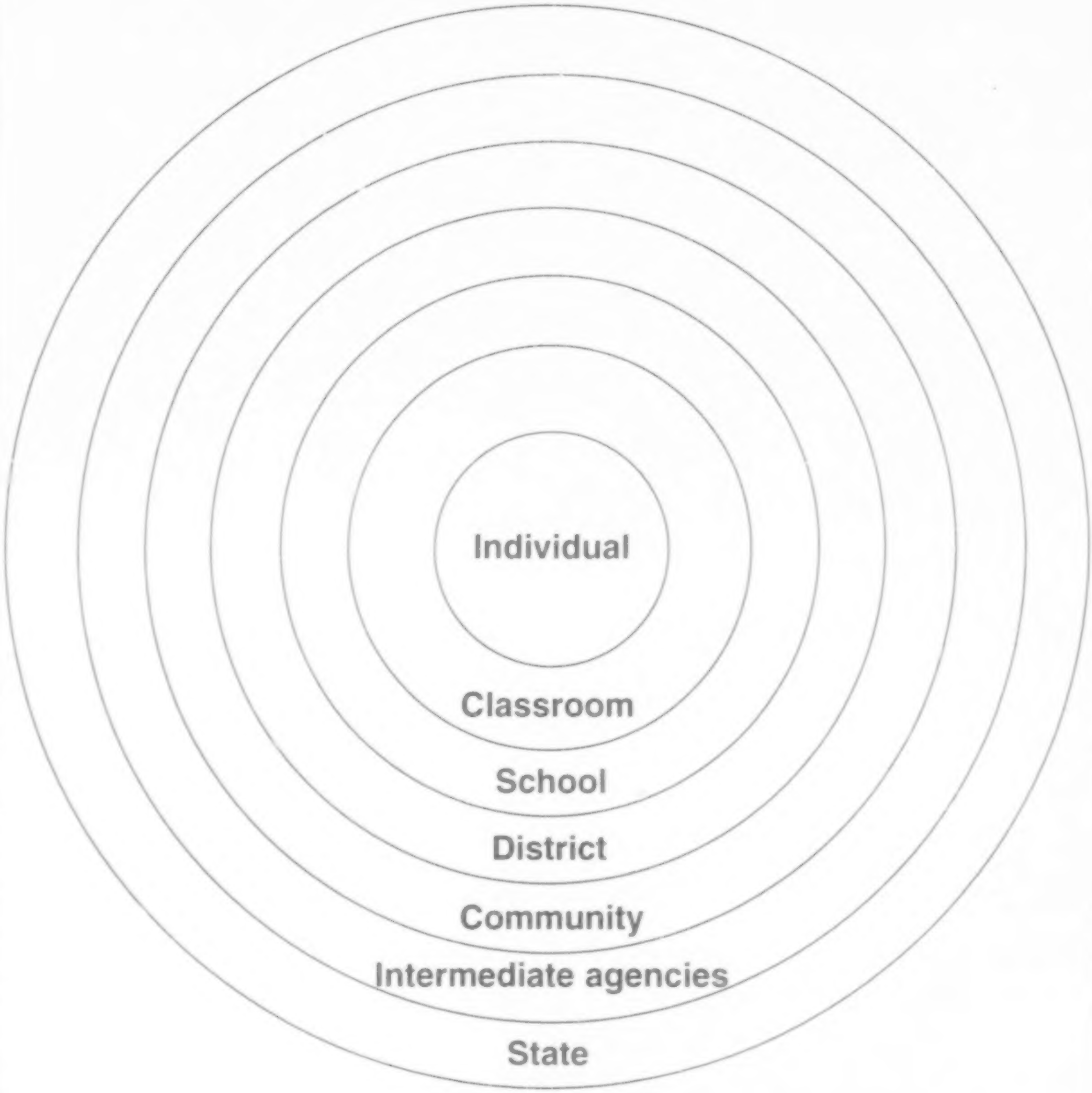
2. What challenges do you currently face?

3. What would you like to know more about that would enable you to work more effectively in your role(s)?

CHANGE AGENTRY


Change Agentry

CONTEXTS FOR PLANNING



Individual

Classroom

School

District

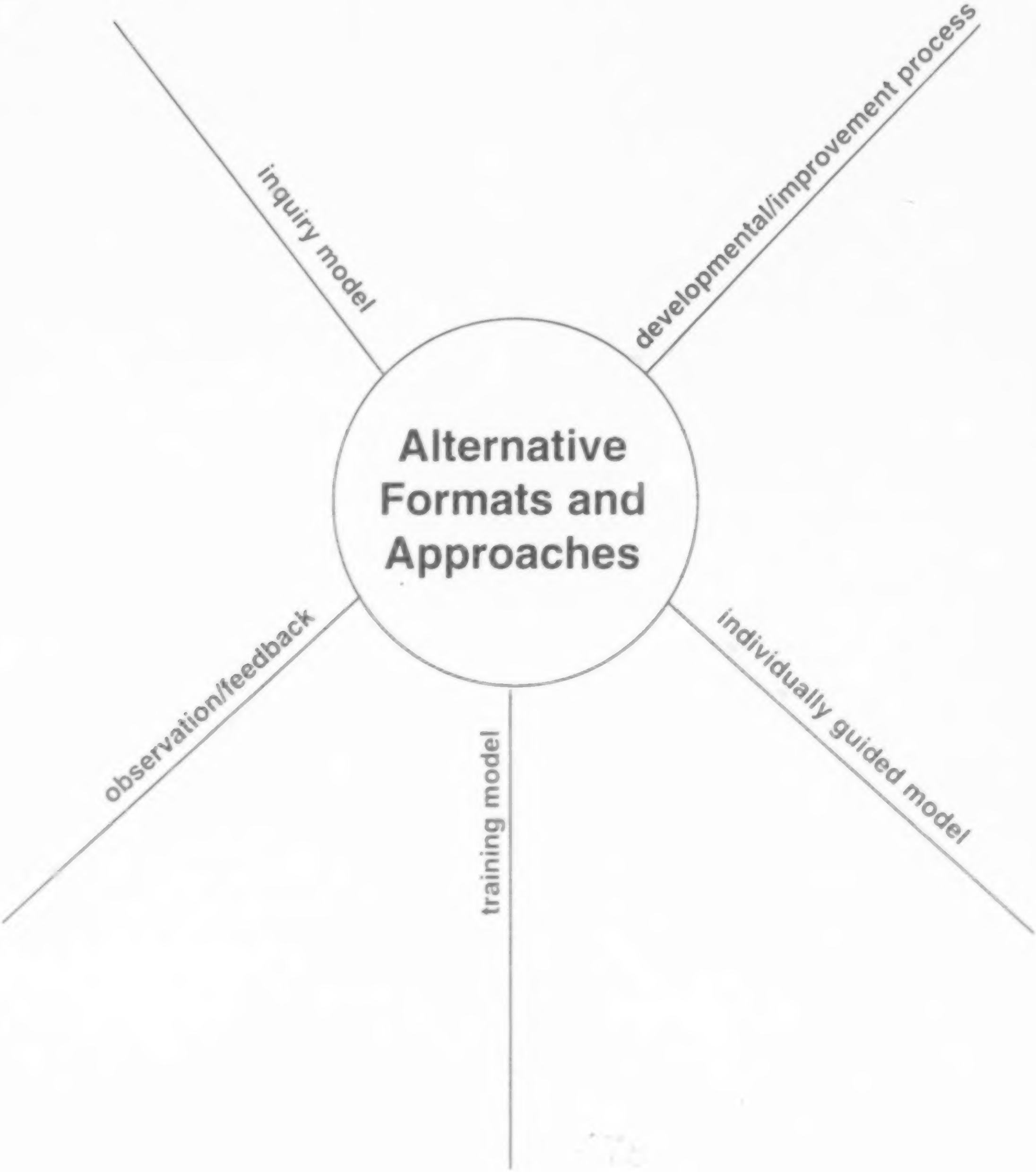
Community

Intermediate agencies

State

Region/Nation

ALTERNATIVE FORMATS AND APPROACHES



Alternative Formats and Approaches

inquiry model

developmental/improvement process

observation/feedback

training model

individually guided model

DETERMINING A FOCUS FOR PROFESSIONAL DEVELOPMENT

1. Establish a Trusting Climate

Needs assessment has a tarnished reputation. Too often, teachers are "needs assessed" to death with no visible results or, at best, a workshop or two on topics of interest. Sometimes a needs assessment is used only to validate decisions that have already been made. It's not surprising that teachers don't always respond with great enthusiasm to yet another needs assessment. Trust in both the outcome and the process of assessment must be established. Communication and genuine involvement help and are critical to the process. Staff need to know what is happening in an assessment, why it's being done, who is doing it, and what will happen with the results. They also need to be involved as participants as well as planners in the assessment process. Staff perceptions of their own needs are important. Recognition of their legitimacy helps to establish trust and commitment. Personalizing an assessment through one-to-one or small group contact also helps to open communication and build trust.

2. Determine Who is Responsible and the Parameters of the Task

Assessment and goal setting is an influential and, therefore, important responsibility, and open and honest discussion about who should be responsible for it is needed. Don't assume that everyone knows or necessarily agrees. Is it the district professional development team? the administrative team? building staff? Will the assessment and goal setting be designed and conducted at the building level or district-wide? This latter question is important and has implications for who should be responsible.

Building-based teams can be particularly effective in these activities because the teachers are credible and know their school, its players, and the data that are available. They can personalize an assessment and play a critical role in gathering and analyzing data. Use of a building team will increase the likelihood that appropriate information will not only be gathered, but used as a basis for action. For a comprehensive assessment, the added numbers are a necessity. A team also assures consideration of multiple perspectives.

Different groups may play different roles in the assessment process. For example, building staff can carry out a district-wide assessment (designed by the district team) in addition to determining and gathering additional information to identify needs and goals peculiar to their school. The district team can determine a district-wide procedure to be used in all schools and survey the results to determine common needs. The school board can determine the focus of the district-wide assessment.

Source: *Building Systems for Professional Growth: An Action Guide* by Margaret A. Arbuckle and Lynn B. Murray. Andover, MA: The Regional Laboratory for Educational Improvement of the Northeast and Islands. ©1989, 5-10 through 5-14.

DETERMINING A FOCUS FOR PROFESSIONAL DEVELOPMENT (continued)

The uniqueness of each school is thus recognized, while still gathering some common data.

The scope of an assessment should also be considered. A needs assessment may be a broad and comprehensive process involving collection and examination of considerable data, internal and external to a school. Such a comprehensive process may take as long as six to eight months, is very educational, and should be conducted every few years. However, it also takes time and other resources. If a school staff is in the midst of implementing new curricula, responding to state mandates and generally feeling stretched and stressed, it may not be the right time for a comprehensive assessment. The availability of resources such as time, staff, money, and secretarial support should be considered and may in part define the scope of an assessment. A good assessment doesn't have to be a big one. It may be very focused and specific, involving considerably less time and collection of information.

3. Decide on a Focus and What Information is Needed to Arrive at It

This is an important step in the assessment process and one that is frequently overlooked. Too often people get captivated by a particular needs assessment instrument which may not in fact gather relevant information. It is important to ask what it is necessary to find out. This question focuses an assessment and suggests information to gather. The focus may be broad or very specific. A broad focusing question is: What are the school's major problems? If in the midst of curricular changes, a more specific focus for a needs assessment might be: What concerns do teachers have and to what extent are they implementing the new language arts curriculum? An example of a guiding question in a "research says" approach to assessing needs is: How do we measure up against effective schooling variables? And finally, if considering some exemplary programs, the focusing question might be: What are three of the hottest (and most successful) programs around, and how do we measure up against them? Each of these questions suggests different sources of information and methods of collection.

The most common sources of information are staff, students, and parents. Information about student academic performance, social performance, and attitudes may be collected. Similarly, data on teacher performance and attitudes can also be gathered. The amount of information collected can vary considerably, depending on what it is necessary to find out. Some of the approaches, such as the problem-focused approach, will probably mean more data collection, whereas others, such as exemplary programs or mandates, may require relatively little.

DETERMINING A FOCUS FOR PROFESSIONAL DEVELOPMENT (continued)

4. Decide How to Collect the Information

A needs assessment doesn't have to be a written survey. There are many different ways to gather information that can help in determining professional growth needs. Commonly used methods include observation, interviews, and questionnaires. It is also possible to determine needs without gathering any new data and instead analyzing information that already exists in the school archives. Examples of archival data include test scores, attendance and suspension records, and program review reports. Most schools have lot of archival data which may be useful.

Use several methods or sources of information. A multi-faceted approach ensures validation of needs and increases the likelihood that needs are legitimate. A combination of tools that draw on the internal knowledge of staff and the external knowledge base on teaching and learning is particularly effective. Multiple information sources are usually necessary to dig, to clarify and define needs, and to get beyond the superficial.

The advantages and disadvantages of different data collection methods should be considered. All techniques, even the popular nominal group process, have both. The methods chosen should match both the focus of the assessment (what needs to be found out) as well as the context of the school. If an instrument is not thoughtfully and appropriately matched to the needs and context of a school, the result can be a collection of irrelevant and useless information. Predesigned instruments are particularly seductive because development time can be skipped. A 100 item written questionnaire designed to measure effective schooling variables in urban high schools is unlikely, however, to yield timely and useful information in a small, rural school suffering from low morale and poor communication. The form itself is likely to increase alienation. Inappropriate data collection only adds fuel to the rightfully tarnished reputation of needs assessment.

Give some thought to the people from whom information is gathered. Eager professional developers often want to gather information from everyone. Care is needed, however. Being asked about wants and dreams implies that something will happen. Be sure that something can be done with the results. If not, it's better not to ask.

5. Collect the Information

No matter how carefully designed an assessment is, it can fail miserably if conducted carelessly. Considering a few questions will help. To start with, who should collect the data? Trust, credibility, and skill should be considered. One high school "excellence" team (which included the principal) prohibited the principal from

DETERMINING A FOCUS FOR PROFESSIONAL DEVELOPMENT (continued)

gathering information from teachers because of the issue of trust. If the plan calls for examining student or staff records, access and confidentiality might be an issue. If observation is planned, the people who have the skills and credibility, as well as trust, will need to do it.

Prior notification of the location and time of a needs assessment can affect its success. Participants in an assessment should be informed in advance of its purpose and a good time and location selected. Early release is often obtained for methods that require several hours. Such a strategy is also a clear statement of administrative support and signals the importance of the activity. Previously scheduled faculty meetings are also commonly used. Time for the assessment is, therefore, not taken from time needed for other responsibilities.

Personalizing an assessment through use of small groups and face-to-face interaction (instead of a written memo) to let people know when something will occur and to give or get information can contribute greatly to a positive and trusting climate.

6. Analyze and Synthesize the Information

Once the data have been gathered, the next step is to analyze and find meaning in them. There are no tricks to this. Groups inevitably have organizers and synthesizers, and these people can be depended on to help. But the task should be given sufficient time, since careful reflection and discussion are necessary if meaning is to be more than superficial.

7. Define the Needs and Identify Improvement Goals

Problem or need definition is a phase of planning that is typically resisted. Most people tend to assume that others perceive the world and interpret information in a similar fashion, leading to similar versions of needs. This is rarely the case. Most data can be interpreted in different ways and discussion – sometimes a lot of it – will help clarify the needs. If the needs are not clearly understood and defined, the likelihood of resolving them is minimal and any improvement strategies will be superficial at best.

Resulting goals should be understandable as well as workable, and controllable. If the success of a goal depends on the involvement and support of others, actions must be taken to ensure their support. Goals should also be limited in number. Enthusiastic staff often try to do too much, resulting in innovation overload. But learning, applying new information, or rethinking old information takes time. It mustn't be shortchanged. Significant improvement efforts should be limited to one or two per year.

DETERMINING A FOCUS FOR PROFESSIONAL DEVELOPMENT (continued)

8. Disseminate Results

The results of the assessment should be reported to all stakeholders as soon as possible. In addition to school staff and school board, this may mean key members of the community and parents. If parents are involved in and informed of the process to identify professional development needs, they are more likely to support the resulting professional development activities.

SUMMARY OF BEST PRACTICES IN NEEDS ASSESSMENT

Although there is not one "correct" method to assess school and staff needs, a number of good practices typical of effective needs assessment have been identified. Experience indicates the importance of the following:

1. *Needs assessment should be a conscious public activity.* Staff and other members of the school community should be informed of what is happening throughout the process. The results of the assessment should be disseminated to those persons who participated in it as well as other audiences who may have an interest. This helps to establish credibility of the programs and commitment to their implementation.

2. *Needs assessment should be an ongoing process.* As staff members become more knowledgeable, their awareness of their needs changes and deepens. Generic needs may be identified initially. An awareness of more specific needs, however, usually follows.

3. *Staff perceptions about their own needs must be viewed as important.* Participants should be involved in planning the needs assessment, prioritizing needs, and deciding about the program. If school staff do not themselves feel a need or desire to change, the content of learning opportunities is far less likely to be assimilated. By making staff partially responsible for assessing their own needs, as well as the needs of others, the process itself becomes educational and part of professional development.

4. *Needs should be individualized by building.* Staff will be more enthusiastic about programs that assist them with their specific needs relative to their job responsibilities. The needs in one building may vary widely from those of another. Individual needs of staff within the buildings may also differ and should be recognized.

5. *Needs assessment information should be gathered from more than one source, using different data collection techniques. Information should be gathered from the minority as well as the majority contingent.* This results in a more comprehensive identification of needs and improves the chances that the needs identified are valid and legitimate, and represent all segments of the population. A survey alone cannot document need.

6. *An analysis should also be made of strengths of the system.* Because needs assessment tends to focus on what is "missing," identification of the strengths of the system and staff can help keep a balanced perspective and can also bolster confidence.

7. *There must be a visible relationship between the needs assessment and the program delivered.* Conducting a needs assessment leads people to expect that programs will be developed to meet those needs.

Source: Adapted from "Needs Assessment for Inservice Education: Building Local Programs," National Inservice Network. ©1980.

FOUR TECHNIQUES FOR NEEDS ASSESSMENT

1. INTERVIEWS

Use interviews when:

- It is necessary to observe not only what a respondent says but *how* (e.g., evasive, eager, reluctant) it is said.
- It is necessary to build up and maintain rapport to keep respondent interested and *motivated to finish questions.*
- *High participation by target group* is needed.
- *Population is accessible.*
- Supplemental information may be needed for *respondent's understanding* and to prevent misinterpretation of the questions.
- *Budget* will allow for expense of this method.
- It is necessary for respondent to react to visual materials.
- *Spontaneous reactions* are necessary with sufficient time and probes to recall relevant information.
- Information about the respondent's personal characteristics and environment is needed to interpret results and evaluate the representativeness of the people surveyed.
- It is desirable to collect information and build support for the idea simultaneously.
- There are *time and resources to properly train and supervise* interviewers (otherwise data recorded may be inaccurate or incomplete).

Major steps:

1. Specify focus of interview – information to be gathered and target audience characteristics.

Source: Adapted with permission of The NETWORK, Inc. from "Needs Assessment Instrument Categories" by Martha Williams. ©1978.

FOUR TECHNIQUES FOR NEEDS ASSESSMENT (continued)

2. Establish time frame and identify interviewers.
3. Develop questions to be included in interview. Check them for bias and sensitivity to the diversity of those being interviewed.
4. Try out the interview.
5. Conduct the interviews.
    a. Motivate the respondent to answer.
    b. Give the respondent a "stake" in the interview (i.e., chance to influence change).
    c. Establish rapport.
    d. Record responses using respondent's own words.
    e. Be prepared to probe for clarification, amplification, etc.
    f. Summarize major points at end as a check.

Sources of interview information:

- Structured questions and structured responses
- Structured questions and open responses
- Semistructured; unstructured

Strengths of interviews as information sources:

- Personal
- Promote support for the process/idea
- Allow for probing and explanation
- Rich data

Limitations of interviews as information sources:

- Take time of both interviewer and responder

FOUR TECHNIQUES FOR NEEDS ASSESSMENT (continued)

- May need to sample responders
- Dependent to some extent on skills and credibility of interviewer
- May be threatening; not anonymous
- Recording and compilation of data more difficult

2. QUESTIONNAIRES/SURVEYS

Use questionnaires when:

- Wide distribution is necessary (and budget will not permit telephone interview).
- A sense of *privacy* is needed.
- *Complete uniformity* in the manner in which questions are posed is necessary to avoid biasing responses.
- *Presence of interviewers* is likely to affect responses.
- Respondent needs to *secure or check information*.
- Obtaining *unanticipated* definitions of situations and quantifiable responses is *not* desired.
- Self administration and ease *are* desired.
- Costs must be kept to a minimum.

Major steps:

1. Specify information to be gathered.
2. Frame questions to be included.
    a. Clear and understandable; logical sequence.
    b. Unbiased and sensitive to the diversity of the population.

FOUR TECHNIQUES FOR NEEDS ASSESSMENT (continued)

   c. Spacing and format make type of response clear.

   d. *Pretest questionnaire* and modify if needed.

3. Determine to whom and how questionnaire will be distributed and how high a return rate will be needed.

   a. Distribute and collect at meeting of respondents.

   b. Self-addressed stamped envelope for return.

4. Compile results of questionnaire and summarize.

Questionnaire/Survey as information sources:

- "Pencil and paper" questionnaire
- "Door-to-door" questions
- "Person-in-the-street" questions
- "Feedback" sheets

Strengths of questionnaires/surveys:

- Quick and anonymous
- Can reach large numbers in a short time
- Easy coding
- Quantifiable information
- Inexpensive
- Can be pre/post measurement
- Can be modified
- Many predesigned questionnaires linked to research on teaching and schools are available
- Those based on research can educate as well

FOUR TECHNIQUES FOR NEEDS ASSESSMENT (continued)

Limitations of questionnaires/surveys:

- No probing, no way to elaborate; must be followed up
- Questions may be interpreted differently
- Need to establish a climate for administering tool
- May be difficult to construct

3. OBSERVATIONS

Use observations when:

- *First hand* experience is required.
- Respondents may not be able to relate directly needed information.
- *Budget* allows for time required for lengthy observations.
- *Sufficient time* in the needs assessment plan is available to make reliable observations

Major steps:

1. Determine format for observation.
    a. Extent to which observation guide is structured prior to observations.
    b. Extent to which observer is or is not a participant in the activity being observed.
    c. Extent to which subjects are aware of observer's role and purpose.
2. Identify site or observational situation.
3. Try out observation form beforehand as a group.
4. Gain access or permission to observe – establish an agreement.
5. Take overt or covert role of observer.

FOUR TECHNIQUES FOR NEEDS ASSESSMENT (continued)

6. Establish trust and rapport (may not be necessary if observation is unobtrusive).
7. Record observations using one or more of the following.
    a. Predetermined schedule or checklist.
    b. Note-taking in narrative form.
    c. Tape record observations as they occur.

Observation information sources:

- Checklists
- Time samples
- Open-ended

Strengths of observation information sources:

- Can be focused or open
- Yields rich, specific, and concrete data

Limitations of observation information sources:

- Takes time of observer
- Not always trusted by persons being observed
- Dependent to some extent on skills of observer

4. ARCHIVAL MATERIAL

Use archival material when:

- Appropriate records are easily and legally accessible.
- *Budget* limits the use of more expensive data gathering methods.
- *Time and space* restrictions do not permit direct access to target population.

FOUR TECHNIQUES FOR NEEDS ASSESSMENT (continued)

- Naturally occurring data from the target setting are desired as opposed to more contrived data from interviews, questionnaires, etc. "Let the record speak for itself."
- Information is needed to *supplement and substantiate information* obtained through interviews and other methods.
- Potential errors in records can be recognized and dealt with through others' needs assessment.
- Comparisons across record-keeping systems are feasible (similar formats, language, type of information).
- Repeated measures of *values, attitudes, etc.* are desired over time.

Major steps:

1. Determine data desired from records.
2. Determine appropriate sources of data. Random stratified or purposive sample of available documents is preferable.
3. Contact persons in charge of appropriate records and gain access to records.
4. Review records for desired information using document analysis techniques. More than one judge is desirable for subsets of documents.
5. Disaggregate information (especially test data) for different sexes, races, and ethnic groups. Only then, summarize information obtained from each record or document with attention to issues of completeness and accuracy.
6. Collapse information across records using emergent categories to gain more general picture.

Sample archival information sources:

- School self-evaluation
- Accreditation
- Vocational education or special education needs assessment

FOUR TECHNIQUES FOR NEEDS ASSESSMENT (continued)

- Student achievement records
- Evaluation of teachers
- Building administrators' reports
- Central administration reports on particular programs
- Grant applications and proposals
- Library check out records
- Attendance records
- Repair bills
- Parent surveys
- School board minutes

Strengths of archival information sources:

- Already available; usually public information
- May be used to support or refute data from another information source
- Good way to "dig"

Limitations of archival information sources:

- No personal contact
- Not always in useable form to synthesize and analyze – for example, it may be impossible to disaggregate by gender, race, and ethnicity to look for differences
- May not know where to find sources

CASE STUDY #1

Mountainview Middle School has spent two years moving from a junior high structure to one that better meets their students' needs: team teaching, block scheduling, student advising, etc. Now they are turning to changes in their program: What curriculum (content and activity) will promote real learning?

Your job is to develop a professional development plan for science and mathematics. You have a sizable budget and a two-year time horizon.

Design a needs assessment.

CASE STUDY #2

Oceanview School District has just adopted a new activity-based science program for all its 20 elementary schools, using a team of teachers, one from each school. Before the adoption, hardly any science was being taught because, according to both teachers and administrators, their largely limited-English student population needed to focus on language development.

It is April. Over the summer the science materials will be delivered to the schools. Your job is to develop a professional development plan; you have a very restricted budget that has to be spent by a year from June.

Design a needs assessment.

CASE STUDY #3

This year, your district has $12,000 in Eisenhower funds to devote to professional development for teachers in its ten schools.

Your job is to develop and implement a professional development plan.

Design a needs assessment.

CASE STUDY #4

The state has just completed its new mathematics assessment system. Each year, students in 4th, 7th, and 11th grade will take a new performance-based test. The superintendent's cabinet has said the district will *not* be on the bottom of state test results this time.

There are 720 teachers responsible for mathematics in your system. You are responsible for developing a professional development plan.

Design a needs assessment.

MANAGING TIPS FOR ENHANCING SUCCESS OF TRAINING

1. Things to do before the training session begins:

   a. Arrive at least an hour before scheduled starting time. (You won't regret it!)

   b. Don't assume anything!

   c. Find the person in charge of the facility and get answers to questions that you've accumulated (e.g., location of rest rooms, arrangement for lunch, how breaks and refreshments will be handled).

   d. Check all equipment for location, be sure that you can operate it, and see that it is working properly. Decide the most efficient and effective way to move and use it given location of electrical outlets, room arrangements, etc.

   e. Check room lights for various grouping plans and for audiovisual use. Locate light switches and test lighting options.

   f. Check all furniture and rearrange as necessary.

   g. Arrange all print materials and supplies on tables for efficient distribution.

   h. Be sure that the registration procedure assures quick, easy sign-in (no lines), and name tags with first names that are large enough to read at a distance. Have the station staffed by efficient, cheerful, helpful people who make participants feel welcome.

   i. Play soft background music while participants are arriving. (Turn it off before beginning the workshop.) *Note:* You can also use music during breaks or to signal the end of a break.

   j. Post relevant, thought-provoking quotes in conspicuous places around the room.

   k. "Buy in" to the topic you are presenting. Convince the audience by your enthusiasm that the topic is extremely important. (If you don't show that you believe in what you're doing, you won't convince others of its value.)

   l. Be prepared for a few surprises.

   m. Greet participants at the door in a warm, friendly manner. Shake hands and try to remember first names.

Source: Adapted with permission of Appalachia Educational Laboratory from *Targets for Trainers*, developed by Dr. Jackie Walsh and sponsored by Kentucky LEAD Center. ©1992.

MANAGING TIPS FOR ENHANCING SUCCESS OF TRAINING (continued)

2. Things to do during or throughout the training session:

   a. Begin on time. (Don't penalize those who are punctual by waiting for those who are not.)

   b. End on time. (Holding people five to ten minutes after announced adjournment time – without their expressed consent – can have negative consequences for an otherwise successful workshop.)

   c. The first few minutes of a workshop are crucial. Use all of the interpersonal skills at your command to establish rapport, set the time, and get off to a good start.

   d. Use creative ways to introduce participants early in the workshop.

   e. Provide a workshop introduction/overview/orientation, review the agenda (giving a preview of what is to come), and take care of housekeeping matters (e.g., breaks, location of rest rooms, provisions for smoking, refreshments, lunch).

   f. Explain the "ground rules" and discuss expectations/responsibilities/procedures (e.g., distribution and use of materials, freedom to move around, holding of participant questions, participant input, and involvement).

   g. Get participants involved early with short warm-up activities and opportunities for input/discussion/reaction.

   h. Invite relevant questions and provide opportunities for interaction with trainer and between and among participants. (Don't allow digressions, however.)

   i. Be a "model" trainer – make a conscious effort to model effective trainer behaviors.

   j. If co-training, don't criticize or embarrass one another in front of participants.

   k. Use efficient, time-saving ways to distribute materials, group participants, and make transitions.

   l. "Size up" the audience, note participant "types," and consider various strategies for coping with those having a negative effect on the group. (Don't let "problem" participants ruin the training. Deal with disruptive or inappropriate behavior when it occurs.)

MANAGING TIPS FOR ENHANCING SUCCESS OF TRAINING (continued)

m. Be prepared to make adjustments in the workshop to meet the needs of participants.

n. Establish and maintain a comfortable pace for yourself and participants. (Don't let it drag, but don't move too fast and lose your audience.)

o. Be a clock watcher! Try to follow the time schedule, but if some especially interesting and productive activity takes longer, be flexible enough to adjust. This can often be accomplished by eliminating or shortening other activities (e.g., instead of completing some later activity, you may decide to introduce it and give participants a "flavor" or "feel" for it without spending time to finish it.)

p. Demonstrate a positive attitude, genuine concern, and total commitment.

q. Establish credibility the old-fashioned way – earn it! Be knowledgeable and exhibit confidence in your ability as a trainer, but don't pose as an "expert" on every topic. (Don't tell participants how to do it. Suggest how you do it or some ways in which others have been successful.)

r. Be professional at all times.

s. Be a facilitator of learning, not a dispenser of facts.

t. Treat participants like the adults they are. (Don't be condescending or "talk down" to participants).

u. Practice sound principles of adult learning.

v. Don't waste participants' time with trivia or "filler."

w. Review, summarize, and check frequently for participant understanding and attentiveness.

x. Acknowledge participant ideas/contributions and use when possible. Capitalize on the experience and expertise of the participants and give everyone a chance to contribute.

y. Note ways to modify various aspects of both content and process for future improvement.

MANAGING TIPS FOR ENHANCING SUCCESS OF TRAINING (continued)

3. Things to do after the training session:

   a. If possible, be available for informal exchanges with participants who may wish to ask follow-up questions, secure additional information, etc.

   b. Pick up and repack extra materials, etc., and check to be certain that you repack all of the supplies, equipment, and materials you brought with you.

   c. Determine who is responsible for putting the room "back in order." Sometimes you can buy lots of goodwill by assisting in the cleanup.

   d. Retain names and addresses of contact people so that you can write "thank-you" notes and conduct the necessary follow-up with these parties.

   e. Retain names and addresses of participants so that you can conduct any appropriate follow-up activities or evaluation with them.

   f. Analyze evaluation data, and consider how you might use these results to improve subsequent workshops. (Do this as soon as possible following training before things get "cold.")

   g. Reorganize trainer and participant materials ASAP after the training event so that you will be "on call" for the next engagement.

A CHECKLIST FOR PLANNING A PROFESSIONAL DEVELOPMENT PROGRAM

1. Involve and inform relevant school and community members throughout the planning and implementation of professional development program/activities.

2. Identify information and/or skills to be acquired and determine specific learning objectives.

3. Identify target groups.

   a. Decide who should be involved.

   b. Decide who should *not* be involved.

4. Identify time and funds available.

5. Identify available programs, practices, and other material resources (local, state, national) for information related to relevant improvement strategies.

6. Identify knowledgeable and skilled people to provide training or assistance.

7. Match available resources with your needs (and resources) and select those most appropriate.

8. Determine appropriate format and learning strategies for the program.

   a. Generate a list of possible formats.

   b. Consider the nature and complexity of the learning objectives.

   c. Consider concerns and learning styles of target audience.

   d. Use research on effective professional development practices as guidelines for design of program.

      (1) Are administrators actively involved as participants as well as planners?

      (2) Is the program supported at the outset by building and district administrators?

Source: Building Systems for Professional Growth: An Action Guide by Margaret A. Arbuckle and Lynn B. Murray. Andover, MA: The Regional Laboratory for Educational Improvement of the Northeast and Islands. ©1989, 6-59 through 6-60.

A CHECKLIST FOR PLANNING A PROFESSIONAL DEVELOPMENT PROGRAM (continued)

(3) Do incentives for participation emphasize intrinsic professional rewards? Are disincentives such as inconvenient times and locations avoided?

(4) Are sufficient time and funds allocated?

(5) Is the program design consistent with fundamental principles of good teaching and learning?

- Is the program spaced over time?
- Do the activities focus on job-related tasks the participants consider real and important?
- Are opportunities for peer discussion, observation, and mutual assistance provided and encouraged?
- Does the program include opportunities for demonstration, practice, feedback, and on-site follow-up to ensure real growth?
- Is testing and trying out ideas encouraged?
- Does the program include both common and individualized activities for the participants?
- Are receptive and active roles for participants included?
- Are concrete experiences, assignments, materials used early?
- Are materials that are relevant to participants' professional responsibilities provided?
- Are the program objectives and roles of the participants clear to all?
- Are regular and frequent meetings or opportunities to discuss application of new practices planned?
- If emphasizing affective or performance objectives, does the program involve less than 30 people?
- Are both in-house and outside trainers with appropriate skills used?

(6) Select appropriate format and design program/activities.

A CHECKLIST FOR PLANNING
A PROFESSIONAL DEVELOPMENT PROGRAM (continued)

9. Negotiate specific plans with identified trainer(s)/resource persons.

    a. Discuss desired objectives, outcomes, roles, nature of participants, appropriate format, do's and don'ts of effective professional development practice. (Don't assume anything!)

    b. *Don't discard your role as planner once a consultant has been identified!*

10. Outline a specific implementation plan (who, what, where, when).

    a. Consider basic workshop mechanics.

    b. Include a contingency plan.

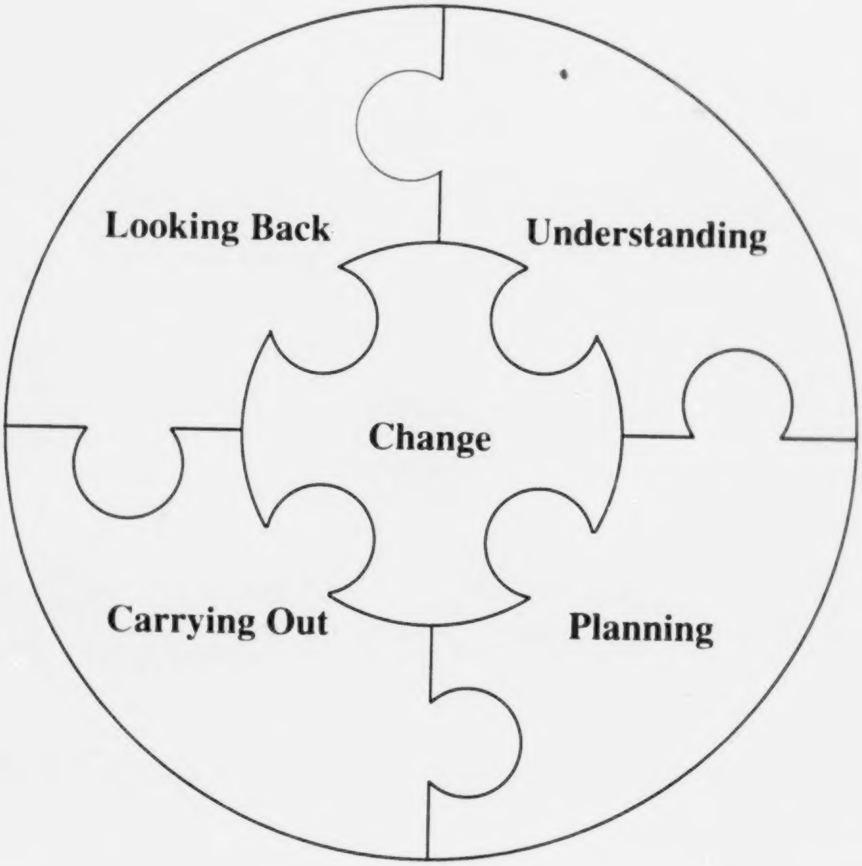
11. Carry out the program.

    a. Through program implementation, document and evaluate what works and what doesn't.

    b. Modify the program as appropriate.

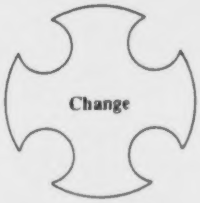
12. Assess the impact of the program over time, on staff as well as students. Reassess the problem/need.

FRAMEWORK FOR DESIGNING EFFECTIVE PROFESSIONAL DEVELOPMENT


Looking Back
Understanding
Change
Carrying Out
Planning

Source: Reprinted with permission of North Central Regional Educational Laboratory from "Framework for Designing Effective Professional Development: Change-Based Inquiry Process" by Cathy Cook and Claudette Rasmussen. ©1994.

FOCUSING ON AND CLARIFYING THE CHANGE

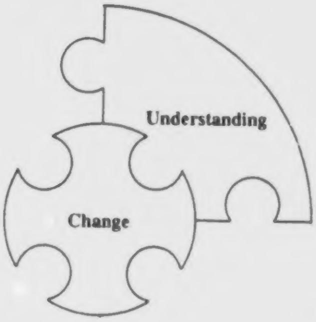


- What is the change you wish to create and/or facilitate?

- In what ways does this change relate to on-going professional development and school improvement?

- How does your design challenge relate to this change?

DEVELOPING AN UNDERSTANDING OF THE CHANGE



- Who, within the varying contexts, might be affected by the change? In what ways?

- What are the belief systems and assumptions about the change? How does this relate to personal and shared vision?

- What questions and needs might they have regarding the change? What is their readiness for this change?

DEVELOPING AN UNDERSTANDING OF THE CHANGE (continued)

- How does this change link to other initiatives?

- Who are the potential advocates of this change? Who should be members of a design team?

- What do members of a design team (change agents and designers of professional development) need to know in order to build understanding?

- In what ways does greater understanding refine or refocus the change?

THINKING ACROSS THE CURRICULUM . . . INTEGRATING PROBLEM SOLVING AND CRITICAL THINKING MODELS

		PHASES	
	BEFORE	DURING	AFTER
MATH Polya's Thinking Phases	Understand • identify assumptions, data (explicit/implicit), question(s) • link real situations Plan • review, understand • brainstorm options • select a strategy/ies • hypothetically set up procedures	Carry out • verify understanding • follow plan • check for reasonable results	Reflect back • analyze effectiveness of plan/group work • identify things to remember for next time/key ideas • share ideas/solutions
READING KW(H)L	Examine what you **KNOW** Determine what it is you **WANT** to know or you **WONDER** Determine **HOW** you will find out	**READ** the material	**REFLECT** on what you learned
SCIENCE Scientific Method	Determine a researchable question • create a problem • hypothesize Develop a procedure and identify materials needed	Conduct the experiment and record the results on a chart/table or graph	Draw conclusions and compare to hypothesis
WRITING Process Writing	Determine context, topic, audience . . . brainstorm, map, web Prewrite • extend map/web • sequence ideas • outline • consider format	Write • rough draft • revise ideas • edit/proof	Share . . . present, publish

Source: Adapted with permission of North Central Regional Educational Laboratory from Problem Solving and Critical Thinking in Mathematics by Cathy Cook and Claudette Rasmussen. ©1990, revised 1994.

THINKING ACROSS THE CURRICULUM . . . INTEGRATING PROBLEM SOLVING AND CRITICAL THINKING MODELS (continued)

	PHASES		
	BEFORE	DURING	AFTER
CONSTRUCT MEANING	Assess/activate prior knowledge Build prerequisite knowledge Develop important vocabulary Establish a purpose for reading Clarify misconceptions	Select and organize important information Monitor and evaluate information	Reflect and integrate prior knowledge with new understandings Summarize and synthesize what has been learned
STUDY SKILLS The 4Cs	Clarify the learning situation Construct a learning strategy	Carry out the strategy	Check results
CREATIVE DECISION-MAKING PROCESS	Recognize and define the problem Plan tentative conclusions	Test tentative conclusions	Evaluate

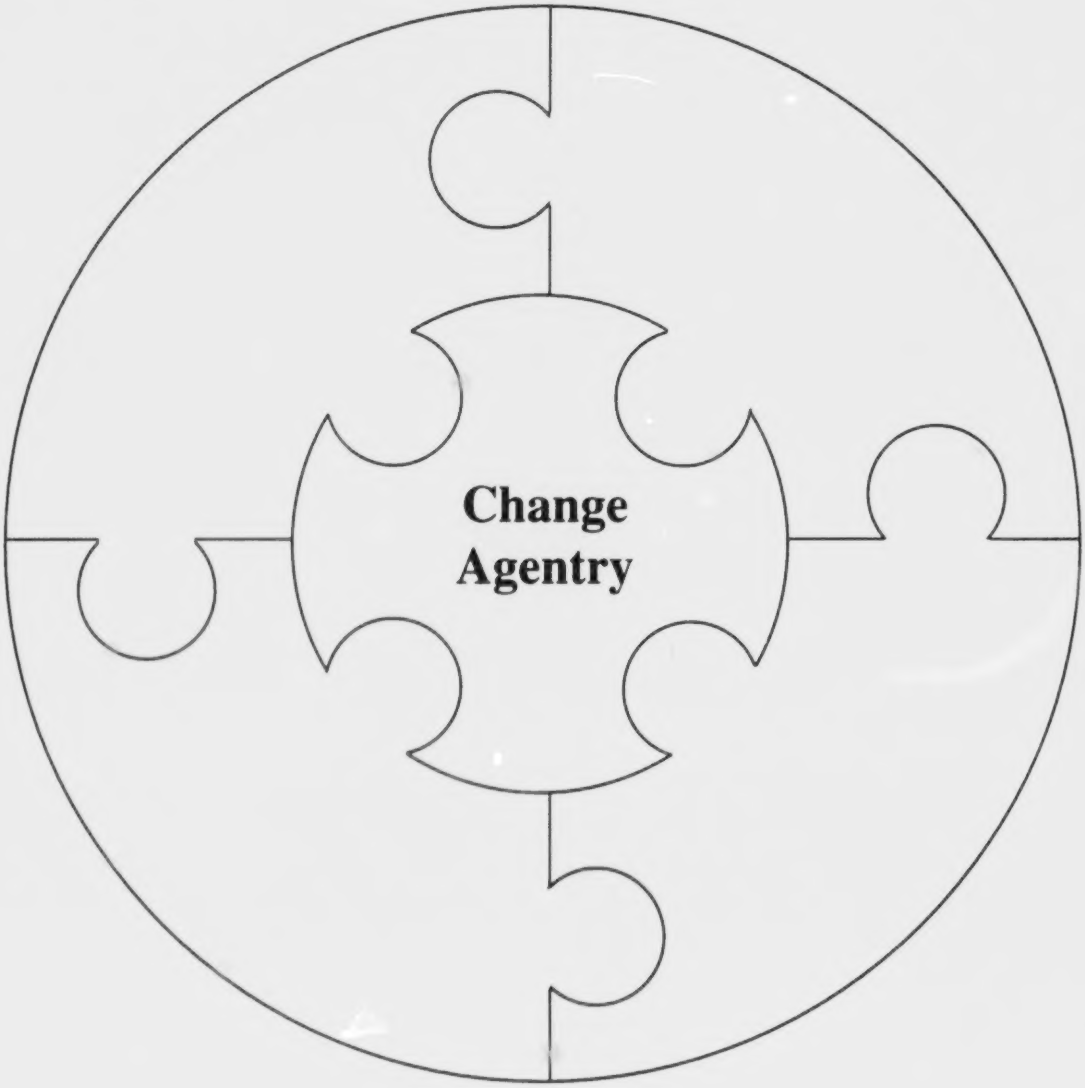
THE CHANGE AGENT'S ROLE:
THINK-PAIR-SHARE

- How would you describe your role as a change agent?

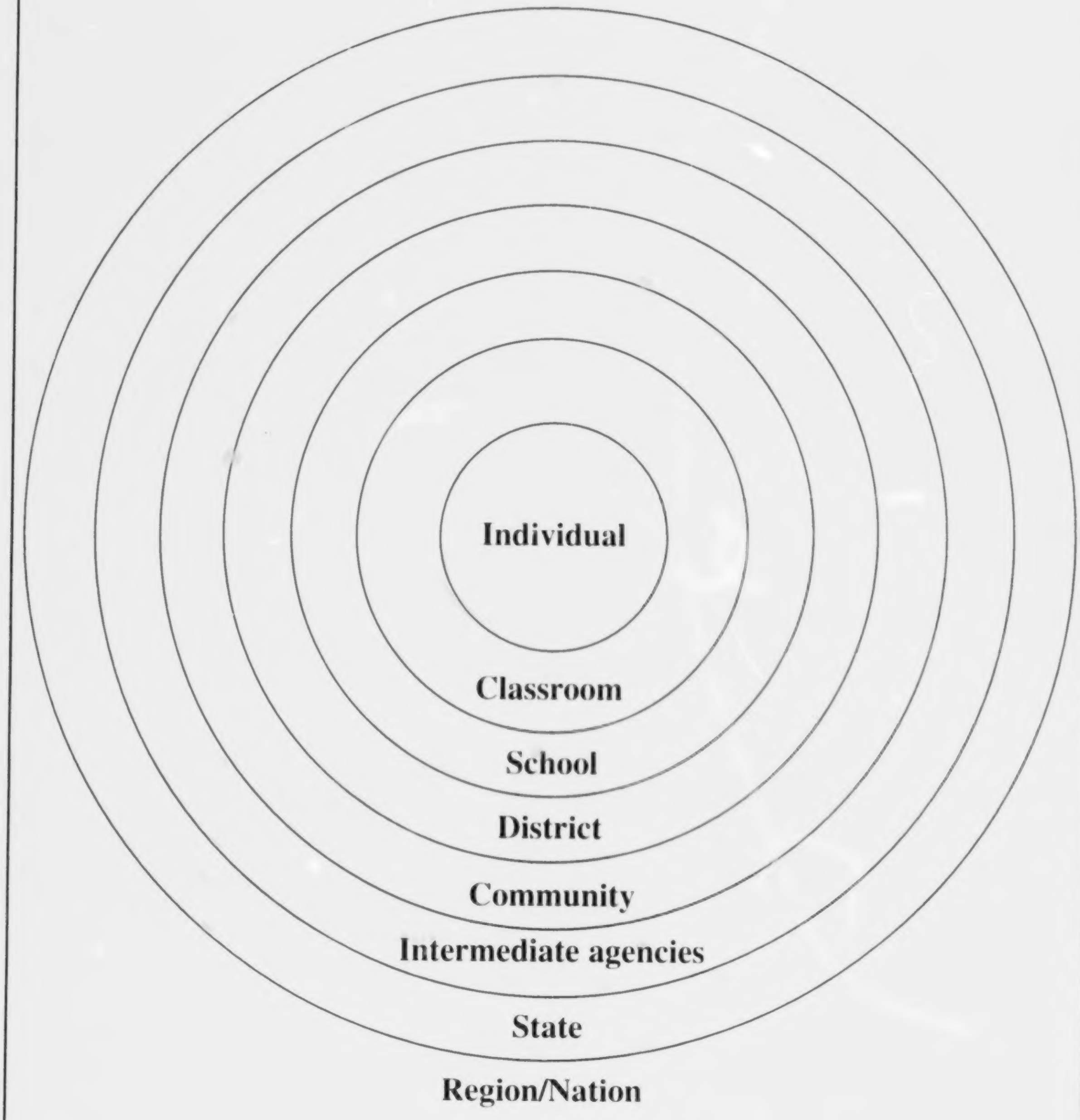
- What challenges do you currently face?

- What would you like to know more about that would enable you to work more effectively in your role(s)?

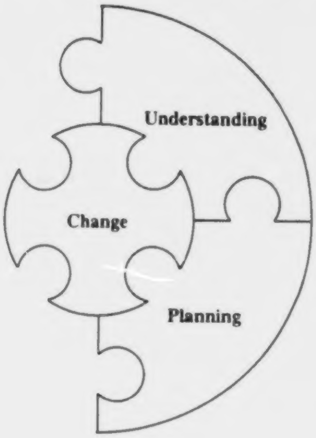
CHANGE AGENTRY


Change
Agentry

CONTEXTS FOR PLANNING


Individual
Classroom
School
District
Community
Intermediate agencies
State
Region/Nation

CREATING A PLAN FOR CHANGE



- What format(s) and approach(es) are used in your professional development design?

- Which formats and/or approaches might be helpful to explore in some detail? Which ones might enhance your plan, given the contexts affected by this change?

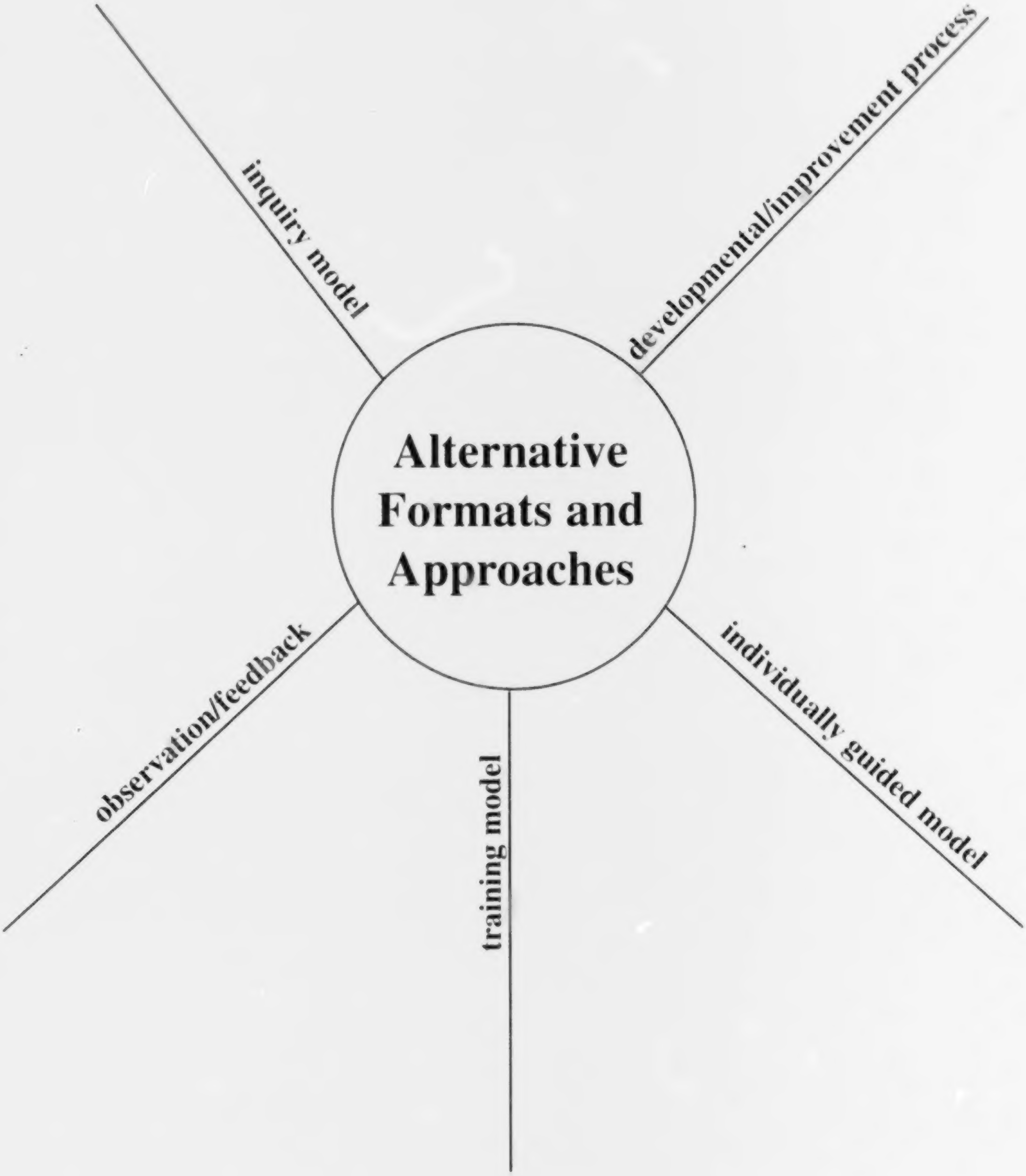
CREATING A PLAN FOR CHANGE (continued)

- How might the chosen formats and/or approaches be integrated and sequenced in an action plan?

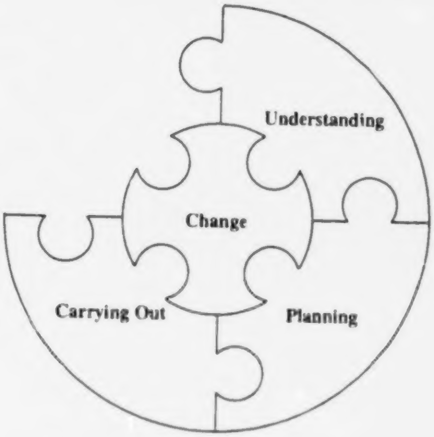
- What are additional potential resources? How might other initiatives be used?

- What is your evaluation plan? Identify possible criteria for evaluating the overall design and process.

ALTERNATIVE FORMATS AND APPROACHES


Alternative Formats and Approaches
inquiry model
developmental/improvement process
observation/feedback
training model
individually guided model

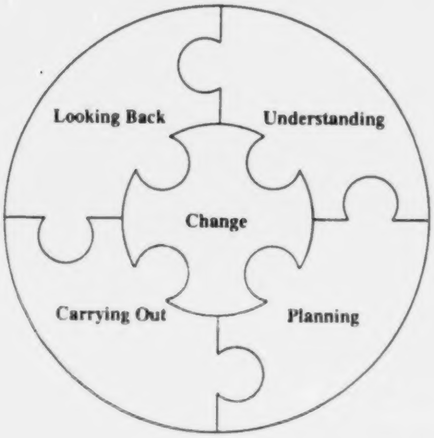
CARRYING OUT THE CHANGE PLAN


Understanding
Change
Carrying Out
Planning

- How might an action plan be used to help manage the implementation of this change?

- How might you use the action plan in formative evaluation (to verify understanding and check for reasonable results), across appropriate contexts?

LOOKING BACK ON THE DESIGN


Looking Back
Understanding
Change
Carrying Out
Planning

- How would you describe the effectiveness of your design?

- How has this design process assisted in the development of an effective design?

LOOKING BACK ON THE DESIGN (continued)

- How might you use evaluation results to further inform and refine your design and process?

- How might formative evaluation results be shared/reported?

- How might you support the maintenance and continuity of this design?

Section V:

Effective Change Strategies

Activity 12: Understanding Change in Individuals: The Concerns-Based Adoption Model 12-1

Activity 13: Research-Based Strategies for Districtwide Change 13-1

Activity 14: Organizational Support for Science and Mathematics Education 14-1

Activity 15: Building Collaborative Teams 15-1

Activity 16: Systems Thinking: A New Mental Model 16-1

Activity 17: A Continuum of Systemic Change 17-1

Activity 18: Expanding Our Understanding of Systemic Change 18-1

Section V: Effective Change Strategies

The purpose of Section V is to introduce participants to a number of dimensions involved in systemic reform, touching on individual, team, organization, and systems change. The section provides an array of concepts, tools, and strategies useful to change agents supporting science and mathematics reform. The activities are:

- **Activity 12: Understanding Change in Individuals: The Concerns-Based Adoption Model.** This model helps participants predict the needs of individuals who are implementing new practices and programs, so they can best plan learning opportunities and support strategies. Participants use the concerns model to identify specific questions and concerns teachers and others have as they engage in science and mathematics reform, as well as strategies to address these concerns.

- **Activity 13: Research-Based Strategies for Districtwide Change.** This activity uses the simulation game, *Making Change for School Improvement*, to help participants develop and extend their knowledge of strategies useful to guide successful change. They play the game as a district planning team and discuss specific implications for their own work in science and mathematics reform.

- **Activity 14: Organizational Support for Science and Mathematics Education.** In this activity, participants identify the different kinds of support needed for successful change in science and mathematics, including material, administrative, time, organizational, and community support. They explore strategies for making that support a reality in their own situations.

- **Activity 15: Building Collaborative Teams.** Systemic change requires collaboration. This activity provides participants with a variety of tools, techniques, strategies, and perspectives that can be useful when working in teams.

- **Activity 16: Systems Thinking: A New Mental Model.** This activity helps participants examine the differences between traditional thinking about education and systems thinking. They work on scenarios familiar to those attempting to change science and mathematics teaching and learning and apply their insights to their own situations.

- **Activity 17: A Continuum of Systemic Change.** In this activity, participants identify the parts of the education system and what will be necessary in order to effect significant reform in science and mathematics. They identify which elements of their own systems they need to work on and plan immediate action steps.

- **Activity 18: Expanding Our Understanding of Systemic Change.** This activity provides participants with an opportunity to read and discuss significant publications dealing with systemic change and apply the ideas to their own situations.

Activities from Section V have been used in many settings, including:

- A statewide mathematics and science leadership conference used the movie clip from Activity 1 to begin a discussion of systemic change. It then continued with Activities 16 and 17, as participants identified components of their education system and developed new understandings of how change in one part of the system impacts on the rest.

- District teams planning for reform of their science programs played the simulation game in Activity 13 and used it as a way to plan their long-term strategy for districtwide change. They also participated in Activity 12, identifying the Stages of Concern of staff in their schools, which helped them plan specific presentations, workshops, and support activities that would further their change effort.

12

UNDERSTANDING CHANGE IN INDIVIDUALS: THE CONCERNS-BASED ADOPTION MODEL

Audience:

- Individuals responsible for designing and supporting change in science and mathematics at all levels.

Desired Outcomes for Participants:

- To describe the assumptions of the Concerns-Based Adoption Model (CBAM) and explain the seven Stages of Concern.
- To use the model to design science and mathematics improvement efforts and assist individual teachers and others according to their needs.
- To explore where individual change fits in the concept of systemic change.

Materials:

- **Transparencies:**
  - *Assumptions of the Concerns-Based Adoption Model* (CBAM) (12-9)
  - *Fuller's Sequence of Concerns About Teaching* (12-10)
  - *Stages of Concern* (12-11)
- **Handouts:**
  - *Concerns About Science/Mathematics Programs* (12-12)
  - *Stages of Concern* (12-13)
  - *Examples of Concerns About Science/Mathematics Programs* (12-14)
  - *Stages of Concern as They Relate to New Directions in Mathematics Education* (12-15 and 12-16)
  - *Stages of Concern Matrix* (12-17)
- **Reading:**
  - "Making Change in Schools" by Jeannette H. Gass. *Arithmetic Teacher*, January 1993, 40 (5): 286-289.
- Overhead projector and screen
- Newsprint, easels, markers, tape, and pens or pencils

Time Required: One and one-half hour

Facilitator's Notes: Systemic reform requires attention to how the various parts of the system act together to focus on learning. With the constant emphasis on the big picture, however, it is easy to see how the individuals involved in a change – those whose everyday lives will end up substantially different – can be forgotten. Individual change is a critical dimension of systemic change. As we help people think more systemically, work together in more meaningful ways, and transform their understandings about learning and teaching, we need to be sensitive to how they are feeling and what they are doing so we can give them the most appropriate support.

This activity presents one component of a model for individual development – the Concerns-Based Adoption Model (CBAM). (Other components, including Levels of Use, are addressed in the **Additional References** listed on page 12-8.) Used by facilitators of change for many years, it can support systemic reform in a number of areas: (1) to help introduce and assist people as they shift their paradigms to more systemic thinking; (2) to support selection, introduction, and implementation of specific programs and practices to enhance learning; and (3) to help ourselves as professional developers understand and get support for our own needs as we undergo changes in our roles and ways of thinking and working with people.

The Concerns-Based Adoption Model assumes that individuals grow in both their concerns about and their use of new programs, processes, and ideas; and that in order to support that growth, assistance must be tailored to specific developmental needs. The model recognizes and legitimizes differences in feelings and behavior of staff relative to a change. It also helps staff understand better the process of change and plan accordingly.

The model includes a number of different concepts, instruments, and tools that can be learned about through reading or training. Science and mathematics educators have used the CBAM to design, trouble-shoot, monitor implementation, and evaluate their efforts to make change in programs or teaching strategies. The short overview included in this *Toolkit* can sensitize people to the basic ideas in the CBAM so they can be used informally in thinking about and planning for change.

The process outlined below requires that you have some knowledge of the CBAM. The reading "The Name of the Game Is Change," enclosed in **Activity 13: Research-Based Strategies for Districtwide**

Change, will help, but we recommend reading one or both of the **Additional References** on page 12-8 as well.

Process:

1. Begin by telling participants that with all the talk about changing the system, it's sometimes easy to forget there are people involved. Note the importance of individuals to systemic reform and the requirement to pay attention to their needs for support. Tell them that in this activity you're going to share with them a model of the change process that helps them think about how individuals experience change and how it can be made less traumatic for all the people involved.

2. Explain that they will begin to discuss what change is all about by sharing a common experience with change.

   Ask them to pick a partner, stand up facing that person, and look each other over. After a minute, get their attention, and ask them to turn back-to-back and change five things about their appearance.

   After three to four minutes ask them to turn back again and see if they can identify the changes. When most have done so, ask them to turn back-to-back again and change five *more* things about their appearance. After they have done so (three to four minutes), ask them to sit down. (*Note:* You have not asked them to interact again with their partners, for good reason. Later in the debriefing you will ask whether their changes still exist, and all will learn how hard it is to make changes that last.)

   Explain that this experience is likely to have many things in common with changes they have made or been asked to make in the past. Debrief the activity by asking and discussing these questions, and then making the summary remark in italics:

   - How did they feel? (They will say awkward, excited, uncomfortable, challenged, stupid, vulnerable, etc.)

     Different people respond to change differently.

   - How many took something off? Put something on? (More will have taken something off.)

     People think of change as a loss – as having to give something up – rather than doing something to enhance what they're already doing.

- How many exchanged something with somebody else? (Few will have done so.)

  People think of change as something they have to do alone.

- How many ran out of things to change? (Most.)

  People never think they have enough resources.

- In what ways were the second changes you made different from the first? (Usually more creative, more fundamental.)

  People will often change superficially first; only when deep change is required and supported will it happen.

- Ask for any other ways this activity connects to their own experiences with change. Finally, ask whether the second set of changes they made still exist. (Probably not.)

  Changes don't remain unless people pay attention to sustaining them.

3. Explain that you want to familiarize them with a model that can help them make sense of and deal with all these issues about change.

   Ask participants to complete the handout **Concerns About Science/Mathematics Programs** (**12-12**). When they have done so, ask them to share their responses to #1 with a partner for three to four minutes. Ask for some of the concerns people wrote down. Say you'll come back to those shortly (see Step 10 and Step 13).

4. Show the **Assumptions of the Concerns-Based Adoption Model (CBAM) (12-9)** transparency. (*Note:* The word "innovation" is used here to refer to any new idea, program, practice, or process that requires new behaviors – one that is new to the person, not necessarily to education.) Explain that the Concerns-Based Adoption Model was first developed in the early 1970s, a time for great change in education, by the University of Texas' Research and Development Center for Teacher Education. These are the assumptions upon which the model was based. Explain each:

   - "process . . ." – takes time and effort over time; can't happen over night.

- "individuals . . ." – to say a school has changed, the individuals within it must change.
- "personal . . ." – all of us experience change differently, depending on our experience, personality, and circumstances.
- "developmental . . ." – there seem to be patterns to how people change, both in the feelings they have towards something new and in their knowledge and skill in using it; the patterns are developmental, much like the theories of Piaget and Maslow.
- "interventions . . ." – what we do to help people must first be related to where they are, then to what it is they're "using" or thinking about using.

5. Explain: *The "seed" for the CBAM was planted in the late 1960s with the work of Frances Fuller on the concerns of teachers about teaching. Her work was in teacher education. She found that there was a developmental pattern to the feelings prospective teachers had about being teachers as they experienced their new role.*

   Show the **Fuller's Sequence of Concerns About Teaching (12-10)** transparency. Explain: *Until prospective teachers had the opportunity to get into classrooms, they had UNRELATED Concerns, i.e., their concerns were unrelated to teaching. They were concerned about getting a date for the concert, getting along with their roommate, passing Western Civilization. As they began to practice being a teacher – got into student teaching – they first had SELF Concerns, i.e., concerns about their ability to succeed in the job and about what that job really meant to them. They were concerned about whether their cooperating teacher would like them, whether they would like kids enough to be with them all day. As they had more experience and began to resolve their self concerns, they began to have TASK Concerns, or concerns about how to manage what they were doing. They wondered why it was taking so long to prepare for the next day, where to get materials, why the kids always had their hands up. Later, as these concerns were resolved they began to have IMPACT Concerns, or concerns about how students were learning. In fact, few prospective teachers had impact concerns before graduating, but Fuller found them in inservice teachers (although there were many with task concerns as well).*

6. Comment: *Researchers at the Texas R&D Center tried to help universities redo their teacher training programs based on Fuller's work and soon realized that university professors expressed early, self*

concerns when confronted with the idea. This led to an expansion of the idea of concerns, looking at adopters of innovations in many different settings. They found, through additional research, that Fuller's stages actually represented seven different kinds of concerns.

7. Show the **Stages of Concern (12-11)** transparency and distribute the handout **Stages of Concern (12-13)**. Talk through the stages. Make sure to point out that Stages 4-6 are impact concerns: they are focused on what I/we can do to better reach learners; it's okay to be at any stage but what's not okay is for people in responsible positions not to address whatever concerns people are experiencing; that people can have many different concerns at the same time, but usually one or two are the most intense.

8. Explain: *There are three ways of assessing concerns. One way is through use of a 35-item questionnaire that can be used with any innovation (note that this questionnaire is included in the book* Taking Charge of Change, *listed in the* ***Additional References*** *on page 12-8). The second is by being a good listener, and by probing for concerns when talking to someone. Another way is through written statements called Open-Ended Statements of Concern. We simply ask people to write a response to the statement, "When you think about _________, what are you concerned about?"*

9. Distribute the handout **Examples of Concerns About Science/ Mathematics Programs (12-14)**. These are examples of the kinds of paragraphs that teachers write. Ask participants to determine the primary concerns for each. Answers: 2, 4, 3 (with a bit of 2).

10. Ask participants to return to the handout **Concerns About Science/Mathematics Programs (12-12)** (see Step 3). Either in pairs, groups, or all together, have them try to score the top part. "Real world" scoring is often harder than exercises. Ask them to reflect on their own concerns. Are they at higher stages than the people they are working with? If so, it's important to address those folks' concerns, not their own, when deciding what help they need. Are their own concerns personal and informational? If so, it's important to recognize where you are too, and try to get the support you need. Stages of Concern can form a common language to talk about how we're feeling and what we need to succeed in our work.

11. Explain: *Why worry about concerns? One reason is it helps us plan how to introduce and support teachers, administrators, community members, and others in their efforts to change. We know that early in a change, people have information and personal concerns. They want to know, "What is it?" and "What does it mean for me?" When they*

first use something new, they are likely to have management concerns. With something significantly different, these concerns may last a couple of years. When those concerns are resolved and things smooth out, people either "plateau" out and don't have many identifiable concerns, or they develop higher stage concerns, where they're making changes for kids.

Divide participants into seven groups of two to five people. Assign each group one Stage of Concern. The task of the group is to identify as many ways as they can to help someone whose primary concerns are at that stage. Remind people that there are many ways and sources for help. Allow 10 to 15 minutes and have them record their ideas on newsprint.

12. Distribute the handout **Stages of Concern as They Relate to New Directions in Mathematics Education (12-15 and 12-16)** and explain that this is one example of how a matrix may be completed for Stages of Concern interventions. Then distribute the handout **Stages of Concern Matrix (12-17).** Ask them to work in pairs to complete the matrix with reference to a science or mathematics program they're working with. Do one stage as an example. Allow 20 minutes to complete the matrix.

13. After completing the matrix ask them to discuss the following questions, referring back to the handout **Concerns About Science/Mathematics Programs (12-12)** (see Step 3):

    - What concerns were expressed by the teacher you reported on in #1 of the handout?

    - What ways could you help him or her?

    Allow ten minutes.

    Ask them to consider their own concerns (bottom of the same handout): remind them that it's legitimate for them, too, to have concerns. What are some ways their own concerns might be addressed?

14. Ask for questions or comments about implications of the idea of Stages of Concern for their work. You may want to ask such questions as:

    - What are ways you might introduce your ideas and programs to people?

- How can you get people on board? Increase buy-in?
- What should your timeline be for training and follow-up?
- Whom should you talk to about concerns?
- How can you find out about peoples' concerns? How can you keep tabs on them?
- What kinds of concerns would you like people to have and by when?

Distribute the reading "The Name of the Game Is Change" from **Activity 13: Research-Based Strategies for Districtwide Change** for future reference.

15. Ask participants to consider their definition of systemic change which they generated in **Activity 1: Framing the Dialogue Around Systemic Change**. How do they think the CBAM fits?

Additional References:

Hord, Shirley M.; William L. Rutherford; Leslie Huling-Austin; and Gene E. Hall. 1987. *Taking Charge of Change*. Alexandria, VA: Association for Supervision and Curriculum Development and Austin, TX: Southwest Educational Development Laboratory.

Loucks-Horsley, Susan and Susan Stiegelbauer. 1991. "Using Knowledge of Change to Guide Staff Development." In Anne Lieberman and Lynne Miller, eds., *Staff Development for Education in the '90s: New Demands, New Realities, New Perspectives*. New York: Teachers College Press, 15-36.

ASSUMPTIONS OF THE CONCERNS-BASED ADOPTION MODEL
(CBAM)

CHANGE:

- Is a PROCESS, not an event
- Is made by INDIVIDUALS first, then organizations
- Is a highly PERSONAL experience
- Entails DEVELOPMENTAL growth in feelings and skills

INTERVENTIONS must be related to:

- The people first
- The innovation second

FULLER'S SEQUENCE OF CONCERNS ABOUT TEACHING

IMPACT

TASK

SELF

UNRELATED

STAGES OF CONCERN

IMPACT	6	Refocusing
	5	Collaboration
	4	Consequence
TASK	3	Management
SELF	2	Personal
	1	Informational
	0	Awareness

Source: Adapted with permission of the authors from *Taking Charge of Change* by Shirley M. Hord, William L. Rutherford, Leslie Huling-Austin, and Gene E. Hall. ©1987.

CONCERNS ABOUT SCIENCE/MATHEMATICS PROGRAMS

1. Think about a recent interaction with a teacher (or other client) about a change in his or her science or mathematics program. It could be a change that he or she is making now or considering making in the future. Describe some of his or her concerns about the change:

2. When you think about your role in facilitating change in science or mathematics, what are you concerned about?

STAGES OF CONCERN

Typical Expressions of Concern About an Innovation

	Stages of Concern	Expression of Concern
IMPACT	6. REFOCUSING	I have some ideas about something that would work even better.
	5. COLLABORATION	How can I relate what I am doing to what others are doing?
	4. CONSEQUENCE	How is my use affecting learners? How can I refine it to have more impact?
TASK	3. MANAGEMENT	I seem to be spending all my time getting materials ready.
SELF	2. PERSONAL	How will using it affect me?
	1. INFORMATIONAL	I would like to know more about it.
	0. AWARENESS	I am not concerned about it.

Source: Adapted with permission of the authors from *Taking Charge of Change* by Shirley M. Hord, William L. Rutherford, Leslie Huling-Austin, and Gene E. Hall. ©1987.

EXAMPLES OF CONCERNS ABOUT SCIENCE/MATHEMATICS PROGRAMS

Example 1

When I think about how this new mathematics program may influence how others see me as a professional, I wonder whether I want to become involved in it. I might have very little to say about how the program is implemented or who I would work with. I'm just not sure how it would fit in with the way I enjoy doing things, nor do I know how I'd be expected to change if we really get involved with the program.

Example 2

Some of the students don't seem to be catching on to these new self-paced science kits. They seem to need more monitoring, closer supervision, and fewer distractions. I wonder if it might help for my aide to work with them more closely as a group.

Example 3

Almost every night I wonder if I'll be able to locate and organize the material I will be using the next day. I can't yet prevent surprises that cause a lot of wasted time. I am not yet able to anticipate what things I will need to have on hand for next week. I feel inefficient when I think about how I'm using the program.

Source: Adapted with permission of the University of Texas at Austin from *A Manual for Assessing Open-Ended Statements of Concern About an Innovation* by Beulah W. Newlove and Gene E. Hall. ©1976.

STAGES OF CONCERN AS THEY RELATE TO NEW DIRECTIONS IN MATHEMATICS EDUCATION

Stages of Concern	Expressions of Concern	Typical Statements	Professional Development, Dissemination, and Other Strategies
Stage 3 **Management Concerns**	Focus on the processes and tasks of implementation: efficiency, organization, management, scheduling, time, and materials.	How do I use these materials? Why is this taking so much time to plan? What grouping strategy will work best?	1. Focus on a specific area for change. 2. Answer specific "how-to" questions. 3. Identify sequences of specific activities and set timelines for implementation. 4. Avoid considering future impact at this time.
Stage 2 **Personal Concerns**	Uncertain about personal ability demands of implementing new instruction, relation to reward structure, decision making, areas of potential conflict, and financial or status implications for self and colleagues.	How will I be evaluated by my principal? Do I know enough mathematics to teach this way?	1. Address personal concerns directly (e.g., clarify impact on evaluation). 2. Use personal notes and conversations. 3. Connect teachers who will be supportive. 4. Implement changes progressively over time. 5. Provide encouragement and support – do not push.
Stage 1 **Informational Concerns**	Seeking a general awareness of and details about new directions: characteristics, effects, and requirements for implementation.	What does it look like to use manipulatives in teaching fractions?	1. Provide clear and accurate information. 2. Use a variety of ways to share information (e.g., video). 3. Visit each other's classrooms. 4. Relate changes to current practices (similarities/differences).
Stage 0 **Awareness Concerns**	Little concern or involvement with mathematics.	What mathematics standards?	1. Involve teachers in discussion and decisions. 2. Arouse interest. 3. Give permission not to know. 4. Encourage sharing.

Source: Adapted with permission of the National Council of Teachers of Mathematics "Making Change in Schools" by Jeannette H. Gass. ©1993, 287-288.

STAGES OF CONCERN AS THEY RELATE TO NEW DIRECTIONS IN MATHEMATICS EDUCATION (continued)

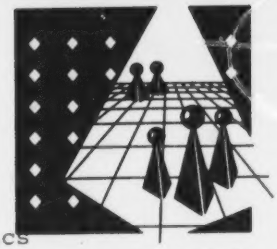
Stages of Concern	Expressions of Concern	Typical Statements	Professional Development, Dissemination, and Other Strategies
Stage 6 **Refocusing Concerns**	Exploring more universal benefits of implementation including major changes or replacement of existing forms.	I think our district would be more successful with "at-risk" students if a project approach were used in mathematics classes.	1. Respect and encourage teacher interests. 2. Channel their ideas and energies; act on concerns. 3. Accept that they may replace or significantly modify existing frameworks. 4. Provide opportunities for visits, participation in institutes, networks, etc.
Stage 5 **Collaboration Concerns**	Coordination and cooperation with others to better meet the needs of all their students.	Wouldn't it be better if our grade level team planned our mathematics instruction together?	1. Provide opportunities to develop skills needed to work collaboratively. 2. Bring people together. 3. Rearrange schedule so people can collaborate. 4. Encourage teachers to provide technical assistance to other teachers. 5. Encourage – don't force – collaboration.
Stage 4 **Consequence Concerns**	Impact of implementation on students; refining so students benefit.	Is all this effort really making a difference for my students? What can I do to improve student learning?	1. Provide teachers with opportunities to visit others and attend conferences. 2. Provide positive feedback and needed support. 3. Provide opportunities for teachers to share knowledge and skills. 4. Provide student and program assessment strategies. 5. Provide training in peer coaching.

STAGES OF CONCERN MATRIX

Stages of Concern	Expressions of Concern	Typical Statements	Professional Development, Dissemination, and Other Strategies
Stage 6 **Refocusing Concerns**	Exploring more universal benefits of implementation including major changes or replacement of existing forms.		
Stage 5 **Collaboration Concerns**	Coordination and cooperation with others to better meet the needs of all their students.		
Stage 4 **Consequence Concerns**	Impact of implementation on students; refining so students benefit.		
Stage 3 **Management Concerns**	Focus on the processes and tasks of implementation: efficiency, organization, management, scheduling, time, and materials.		
Stage 2 **Personal Concerns**	Uncertain about demands of implementing new instruction, relation to reward structure, decision making, areas of potential conflict, and financial or status implications for self and colleagues.		
Stage 1 **Informational Concerns**	Seeking a general awareness of and details about new directions: characteristics, effects, and requirements for implementation.		
Stage 0 **Awareness Concerns**	Little concern or involvement with mathematics.		

Source: Adapted with permission of the National Council of Teachers of Mathematics from "Making Change in Schools" by Jeannette H. Gass. ©1993, 287-288.

IMPLEMENTING THE *PROFESSIONAL STANDARDS FOR TEACHING MATHEMATICS*



Reprinted with permission of the National Council of Teachers of Mathematics from Arithmetic Teacher, by Jeannette H. Gass. (c) 1993.

Making Change in Schools

I need time to reflect. I've learned so much at this workshop, but I need time to think about what I've learned before I can think about what to do with my students.

I don't know how I'll find a way to add new topics in statistics in my curriculum. I really need to find a way to integrate new and old topics in order to consider all that I must accomplish with my students.

I really would like to meet with other teachers at my grade level so that we can talk about ways to teach using a problem-solving approach. I really would like to share ideas with them about strategies and problems.

I'm very concerned about having to teach algebra to all students. I think this is important to do, but I need help knowing the best ways to make this happen. Right now, a lot of students are not being successful with algebra in my school.

There's all this emphasis on teaching mathematics in new ways. But the methods for assessing learning haven't changed. How do I assess where my students are if I use these new approaches to teaching?

— Comments made by teachers participating
in professional-development programs
in mathematics education

This is a time of rapid change in mathematics education. As a nation, we have made progress toward consensus about many of the important issues related to content, pedagogy, and assessment of mathematics learning at the K–12 levels. Much of this consensus is spoken in the pages of the *Curriculum and Evaluation Standards for School Mathematics* (NCTM 1989) and the *Professional Standards for Teaching Mathematics* (NCTM 1991). Sometimes swiftly, sometimes more slowly, change that reflects the directions of these sets of standards is being implemented at the state, provincial, and local school levels. There is no doubt that the expectations for change in mathematics instruction and for improvement in students' achievement in mathematics are of top priority.

Prepared by **Jeanette H. Gann**
High Point Public Schools
High Point, NC 27261

Edited by **Susan N. Friel**
University of North Carolina
Chapel Hill, NC 27599-3345

Susan Friel directs the University of North Carolina's Mathematics and Science Education Network in Chapel Hill, NC 27599-3345. Jeanette Gann is Director of Staff Development and Mathematical Sciences in the High Point Public Schools in High Point, NC 27261.

The Editorial Panel welcomes readers' responses to this article or to any aspect of the Professional Standards for Teaching Mathematics *for consideration for publication as an article or as a letter in "Readers' Dialogue."*

Change and Professional-Development Programs

Crucial to accomplishing the needed changes in mathematics education are comprehensive and long-term programs in professional development for teachers of mathematics. Such professional development refers to the educational and personal experiences that enhance or change teaching practices toward the end of improving students' learning of mathematics. Teachers, like all professionals, need the support of ongoing professional-development programs to assist them in bringing about changes in their practices, in their beliefs and attitudes, and in the learning outcomes of their students.

What do we know about change in schools? We do know that change is a process, not an event. How we address the process of change will determine how successful we are in implementing the new directions in mathematics education. For most schools and teachers, the idea of change to improve instruction and learning often translates to "this is the year for . . . ." This is the year for implementing teaching with manipulatives; this is the year for implementing the use of technology; this is the year for implementing cooperative learning; and so on. Little attention is given to the individuals who make up the organizations that are seeking to change. Change is a highly personal experience for the individuals involved in the process. Feelings of concern during the process are neither right nor wrong, and acknowledging those feelings is an important part of the change process. Too often little awareness is evident that change entails developmental growth both in feelings and in skills.

A Concerns-based Approach to Change

Considerations of how people change and what people need as they go through a process of change can be addressed through the use of a conceptual framework provided by the Concerns-Based Adoption Model (CBAM) (Hall and Hord 1987; Hord et al. 1987; Loucks-Horsley 1989). The concerns-based approach emerged in the early 1970s when many of the innovations that had been introduced in schools were found to be not fully implemented and, therefore, were judged to be unsuccessful. Eventually, the identification of developmental Stages of Concern and Levels of Use in terms of adopting innovations lent insights into why innovations may succeed or fail.

The Stages of Concern dimension of this

FIGURE 1

Stages of Concern as They Relate to New Directions in Mathematics Education

Stages of concern	Typical statements	Expressions of concern	Intervention strategies a change facilitator can take
Stage 0 Awareness concerns	I am not concerned about the new directions in mathematics education.	There is little concern about, or involvement with, the new directions in mathematics education.	1. Involve teachers in discussions and decisions about the new directions in mathematics education and their implementation. This strategy will include providing overviews of the *Curriculum and Evaluation Standards for School Mathematics* (NCTM 1989) and the *Professional Standards for Teacher Mathematics* (NCTM 1991). 2. Share information that will arouse interest but not be overwhelming. 3. Acknowledge that a lack of awareness is expected and reasonable and that no questions about the new directions in mathematics education are foolish. 4. Encourage sharing of information among nonusers and those who are at other stages of implementing the new directions in mathematics education.
Stage 1 Informational concerns	I would like to know more about the new directions in mathematics education.	Concerns focus on getting a general awareness of the new directions in mathematics education and learning more details. The individual is interested in such aspects as general characteristics, effects, and requirements for implementation.	1. Provide clear and accurate information about the new directions in mathematics education. Teachers may want to read some or all of the *Curriculum and Evaluation Standards for School Mathematics* (NCTM 1989) and the *Professional Standards for Teaching Mathematics* (NCTM 1991). 2. Use a variety of ways to share information—verbally, in writing, and through any available media. Communicate with individuals and with small and large groups. 3. Have users who have begun implementing the new directions in mathematics education in other sites (e.g., classrooms, schools) visit nonusers and vice versa. 4. Help teachers see how the new directions in mathematics education relate to current practices in terms of similarities and differences. 5. Be enthusiastic and highlight the visibility of others who also are excited about implementing the new directions in mathematics education.
Stage 2 Personal concerns	How will the new directions in mathematics education affect me?	The individual is uncertain about the demands of implementing the new directions in mathematics education, his or her role in relation to the reward structure of the organization, decision making, and considerations of potential conflicts with existing structures or personal commitment. Concerns about financial or status implications for self and colleagues may also emerge.	1. Take time to address the personal concerns. Legitimize the existence and expression of personal concerns. Knowing that these concerns are common and that others have them can be comforting. 2. Use personal notes and conversations to provide encouragement and reinforce personal adequacy in being able to address the new directions in mathematics education. 3. Connect teachers at this stage with others whose personal concerns have diminished and who will be supportive. 4. Show how the new directions in mathematics education can be implemented progressively over time rather than all at once in one *big* leap. It is important to establish expectations about what is attainable. 5. Do not push the implementation of the new directions for mathematics education. Provide encouragement and support while maintaining expectations.

continued

BEST COPY AVAILABLE

FIGURE 1 (CONTINUED)

Stages of concern	**Typical statements**	**Expressions of concern**	**Intervention strategies a change facilitator can take**
Stage 3 Management concerns	I seem to be spending all my time preparing and managing my instruction in order to implement the new directions in mathematics education.	Concerns focus on the processes and tasks of implementing the new directions in mathematics education and the best use of information and resources. Issues related to efficiency, organization, management, scheduling, and time are utmost.	1. Clarify the components of the new directions in mathematics education. Focus on a specific area for change. Information about how different configurations relate to a specific area is helpful here. 2. Focus on providing answers to specific "how to" issues and give exact and practical solutions to logistical problems that contribute to management concerns. 3. Help teachers identify sequences of specific activities and set timelines for accomplishing movement toward implementing new directions in mathematics education. 4. Pay attention to the immediate demands involved in the implementation program, avoiding consideration of such things as future impact.
Stage 4 Consequence concerns	How is my implementation of new directions in mathematics education affecting my students? In what ways might I refine what I'm doing to have more impact?	Concerns focus on the impact of implementing the new directions in mathematics education on students within his or her most immediate sphere of influence. The focus is on the relevance of the new directions in mathematics education for students, evaluation of student outcomes, and changes needed to improve student outcomes.	1. Provide teachers with opportunities to visit other settings where new directions in mathematics education are being implemented and to attend relevant conferences. 2. Continue to give individuals at this stage positive feedback and needed support. 3. Find opportunities for teachers at this stage to share their knowledge and skills with others. 4. Share with these persons information pertaining to new directions in mathematics education.
Stage 5 Collaboration concerns	How can I coordinate what I am doing in implementing new directions in mathematics education with what others are doing?	Concerns focus on coordination and cooperation with others in implementing the new directions in mathematics education to meet the needs of students better.	1. Provide these individuals with opportunities for developing the skills needed to work collaboratively. 2. Devise ways to bring together people, both within and outside of a school/school district, who are interested in working collaboratively. 3. Work with collaborators to establish reasonable expectations and guidelines for their collaborative efforts. 4. Involve these people in providing technical assistance to others who are in need of assistance. 5. Encourage, but don't attempt to force, collaboration.
Stage 6 Refocusing concerns	I have some ideas about what might work better in terms of implementing new directions in mathematics education. I believe that I can identify other ways than what I am doing that will work even better.	Concerns focus on exploring the more universal benefits from implementing the new directions in mathematics education, including the possibility of major changes or replacement with more powerful alternatives. Individuals have definite ideas about alternatives to the proposed or existing forms for implementing new directions in mathematics education.	1. Respect and encourage the interests these people have in finding other and better ways to implement the new directions in mathematics education. 2. Help these individuals channel their ideas and energies; act effectively on their concerns for program involvement. 3. Be aware of and willing to accept that these people may replace or significantly modify the existing strategies for implementing new directions in mathematics education.

BEST COPY AVAILABLE

model addresses how teachers or others perceive an innovation—for our purposes, the new directions in mathematics education—and how they feel about it. Seven different Stages of Concern have been identified; these stages reflect a hierarchical scheme in which an individual progresses from the "bottom" (or stage 0 or 1) to the "top" (or stage 6).

Stages of Concern

Stage 6—Refocusing concerns
Stage 5—Collaboration concerns
Stage 4—Consequence concerns
Stage 3—Management concerns
Stage 2—Personal concerns
Stage 1—Informational concerns
Stage 0—Awareness concerns

The first stage, Stage 0—Awareness, characterizes a person who has little, if any, knowledge about the new directions in mathematics. The remaining stages reflect three categories of concerns:

- Self-concerns (stages 1 and 2): What is this new change and how will it affect me?
- Task-oriented concerns (stage 3): How do I implement this change? What do I need to do to make this change happen with my students?
- Impact-oriented concerns (stages 4–6): How are my students learning? Are they learning more and are they learning better? How do I work with others who are also implementing these new ideas?

Figure 1 furnishes more detailed information in a top-to-bottom framework for ease in reading.

Research has shown that at different points in the change process, different Stages of Concern about instituting an innovation (i.e., any program, product, or process new to the individuals involved) are more intense. The teachers talking at the beginning of this article reflect, through their own words, their concerns; if questioned further, they would reveal where they are in their own processes of changing with regard to the innovation of implementing new directions in mathematics education.

Progressing through the Stages of Concern takes *time*—more than one year. Indeed, the change process necessary for a new practice or program to become fully implemented takes three to five years at a minimum. The seven Stages of Concern imply that the content and design of intervention strategies will depend on which concerns are more or less intense. The identification and description of stages supply direction for intervention programs. Several suggestions for intervention strategies that help facilitate the process of change with regard to the Stages of Concern are discussed in depth in **figure 1,** which is adapted from Hord et al. (1987).

Essentially, the process of change—the progression through these seven Stages of Concern—involves three levels, or phases. In the *initiation* phase, teachers are learning about a new practice or program. A strong support system furnished through workshops, demonstrations, observations, and on-site support is needed for teachers to address their self-concern issues. Teachers need to participate in the planning at this stage. Their input is needed as part of the process of gathering information about the proposed new practice or program.

During the *implementation* phase, teachers are engaged in trying to implement a new practice or program for the first time. They are responding to their own task-oriented concerns with management—the "how do I do it" question—a central need. A major training event or, better yet, a sequence of events is needed, and ongoing follow-ups are essential. During this phase teachers can quickly give up if appropriate assistance and encouragement are not available.

The final phase, the *institutionalization* phase, reflects the level of impact-oriented concerns. This phase is most often neglected. At this time a new practice or program becomes part of the fabric of the school. Organizational support and leadership, procedures for the orientation of new staff, and systems for maintenance and renewal concerning the new practice or program are established. Without this phase, change cannot be successful. Clearly, this phase will not begin until the end of the second year or during the third year of the process of change.

Change in schools happens to people and is facilitated by people. The CBAM model supplies a framework for examining change as it relates to those who are making the changes. As we look at the new directions in mathematics education, we should consider planning for change in light of the application of the concerns-based approach. Reflect on your own efforts to implement new directions for mathematics education. Where are you in the process of change? Where are your colleagues? What support do you need to continue in your efforts to implement changes in mathematics education? In what ways can you assist your colleagues? Thoughtful reflection on the process of change and on your place in that process will furnish a useful context for overall planning and implementation of programs that address the new directions in mathematics education.

In the CBAM model, the generic term *innovation* is used in focusing the Stages of Concern. In this article, the phrase *the new directions in mathematics education* has been used to replace the more general reference to *an innovation. The new directions in mathematics education*, when addressed in terms of actual implementation, usually are restated to reflect a reference to specific situations such as the following:

- Using manipulative materials to teach number and place-value concepts
- Using a calculator and computer technology to teach algebra
- Serving as an elementary mathematics lead teacher

In any of these situations, teachers experience the Stages of Concerns as they relate to the particular example of new directions in mathematics education in which they are involved.

Bibliography

Fullan, Michael G., and Matthew B. Miles. "Getting Reform Right: What Works and What Doesn't." *Phi Delta Kappan* 73 (June 1992):745–52.

Guskey, Thomas R. "Staff Development and the Process of Teacher Change." *Educational Researcher* 15 (May 1986):5–12.

Hall, Gene E., and Shirley M. Hord, S. M. *Change in Schools: Facilitating the Process.* Albany, N.Y.: State University of New York Press, 1987.

Hord, Shirley M., William L. Rutherford, Leslie Huling-Austin, and Gene E. Hall. *Taking Charge of Change.* Alexandria, Va.: Association for Supervision and Curriculum Development, 1987.

Loucks-Horsley, Susan. "Managing Change: An Integrated Part of Staff Development." In *Staff Development: A Handbook of Effective Practices*, edited by Sarah D. Caldwell, 114–25. Oxford, Ohio: National Staff Development Council, 1989.

Loucks-Horsley, Susan, and Marge Melle. "Evaluation of Staff Development: How Do You Know It Took?" *Journal of Staff Development* (April 1982):102–7.

Loucks-Horsley, Susan, and Suzanne Stiegelbauer. "Using Knowledge of Change to Guide Staff Development." In *Staff Development for Education in the 90's: New Demands, New Realities, New Perspectives*, edited by Ann Lieberman and Lynne Miller, 15–36. New York: Teachers College Press, 1991.

National Council of Teachers of Mathematics. *Curriculum and Evaluation Standards for School Mathematics.* Reston, Va.: The Council, 1989.

———. *Professional Standards for Teaching Mathematics.* Reston, Va.: The Council, 1991.

Richardson, Virginia. "Significant and Worthwhile Change in Teaching Practice." *Educational Researcher* 19 (October 1990):10–18.

13 RESEARCH-BASED STRATEGIES FOR DISTRICTWIDE CHANGE

Audience:

- Individuals responsible for designing and supporting change in science and mathematics at all levels.

Desired Outcomes for Participants:

- To describe principles of and strategies for change based on research.
- To identify change strategies that can be used to support science and mathematics improvement.

Materials:

- *Making Change for School Improvement: A Simulation Game* (one game per 12 participants), available from:
  The NETWORK, Inc.
  300 Brickstone Square, Suite 900
  Andover, MA 01810
  1-800-877-5400
  No. 521 (Purchase) $250.00
  No. 522 (Rental – 10 days) $90.00

- **Transparencies:**
  - *About Change* (13-12)
  - *Expected Outcomes of the Game* (13-13)
  - *Objectives of the Game* (13-14)
  - *Game Agenda* (13-15)
  - *Playing the Game: Strategy Record Sheet**
  - *Things to Remember* (13-16)
  - *Scoring Check-In* (13-17)
  - *Learning the Game: Adopter Types**
  - *Learning from the Game: Assumptions of the Concerns-Based Adoption Model (CBAM)**
  - *Learning from the Game: Levels of Use of the Innovation**
  - *Learning from the Game: Stages of Concern**

- **Handouts made from handout masters in game box:**
  - *Playing the Game: Player Instructions**
  - *Playing the Game: Activities Sheet**
  - *Playing the Game: Strategy Record Sheet**
  - *Learning the Game: Adopter Types**

*Note: Make these transparencies and handouts from masters in the game box.

543

- *Learning from the Game: Assumptions of the Concerns-Based Adoption Model (CBAM)**
- *Learning from the Game: Levels of Use of the Innovation**
- *Learning from the Game: Stages of Concern**
- *Learning from the Game: Learnings Built into Making Change**

- **Reading:**
  - "The Name of the Game is Change" by John Rankin. *R&D Preview*, March 1993, 8 (2): 4-5.
- Overhead projector, screen, and overhead pen
- Newsprint, easels, markers, and tape

Time Required: Three hours

Facilitator's Notes: Playing the Game is a very palatable way for "change agents" to get in touch with some of the research on change, especially as it applies to supporting the introduction and implementation of a new program, process, or strategy to teachers, schools, and districts. While not specific to science and mathematics, participants quickly relate their efforts at making change in the fictitious Verifine School District to the people, programs, and practices they themselves work with on a daily basis.

The enclosed reading at the end of this activity provides a quick overview of the Game. The **Additional References** on page 13-10 can deepen understanding of the research on change and school improvement. We recommend reading them prior to the session and sharing all or parts of the articles to the extent you feel they would be helpful to participants.

Activity 12: Understanding Change in Individuals: The Concerns-Based Adoption Model discussed some of the research underlying the Game and you may choose to simply refer back to that activity, when appropriate, or use Activity 12 *after* playing the Game. It's been done effectively both ways.

The *Leader's Manual* in the Game box suggests a sequence of play. In the Process section, we have included more detailed instructions that can be followed. These are adapted from an action planning design developed by ETR Associates, Santa Cruz, CA, for the Safer Choices Program.

Process:

1. Read the *Leader's Manual* thoroughly and review all parts of the Game. It's best to play the Game yourself before using it with others. Read the **Additional References** listed on page 13-10 for more in-depth preparation.

2. Ask participants to discuss with one or two others at their tables: What are your biggest challenges when you're wearing your "change agent" hat? After four to five minutes ask for a few answers from volunteers.

3. Explain that, although change is complex, there are some patterns to how it unfolds that have been recognized by research and experience. Understanding these can help them as they face their most difficult challenges. Make some or all of the following points, using the **About Change (13-12)** transparency.

   - There are two basic rules of life: (1) change is inevitable, and (2) everybody resists changes.

   - You play a key role in change; you can be instrumental in creating acceptance and support for real change in science and mathematics and seeing that it becomes an integral part of classrooms, schools, and districts.

   - We know from experience that school improvement programs and projects come and go. Some never get off the ground. Some programs are "hot" for a while but die quickly when the topic loses newness, or outside attention ends. Some programs start out well but simply fade over time until the original idea is forgotten.

   - A great deal of research has been done on sustaining innovations, including new programs in schools. The main reason for program failure is that people and practices didn't **change**. The research suggests that there are specific strategies that increase the likelihood that a program will be successful. They have to do with **how** a new idea or program is introduced, and by whom.

   - *Making Change*, a simulation game based on 15 years of research, is a tool for learning these successful strategies for **addressing resistance to change** and **for making change stick** – a major challenge for us in science and mathematics reform.

- This simulation game mimics school life situations. Our purpose in playing the Game is to help you recognize and develop strategies for designing implementation efforts.

- As many of you know, people learn in different ways. We want to address various styles of learning that are generally found in groups. We've had good experiences with the Game. For those of you who are less fond of games, bear with us – there will be an analysis and application of the Game concepts afterwards.

4. Refer to **Expected Outcomes of the Game (13-13)** transparency and **Objectives of the Game (13-14)** transparency. Give the following instructions.

   - Your team represents the Equity Committee of the Verifine School District.

   - You've formed the Committee because you're concerned about equity and want to get the district to plan and implement efforts to insure educational equity for all students. Equity refers to having real access to school programs and services and feeling included, by gender, culture, physical condition, educational achievement, etc. Examples of equity issues include: more boys than girls in science and mathematics classes; textbook illustrations that don't reflect the diverse cultures at the school.

   - The Equity Committee is similar to any curriculum revision or school improvement group, in that it is trying to help people in the district implement and sustain a new program or set of practices. Learnings from the Game apply to **ANY** change effort.

5. Instruct participants to individually read the handout **Playing the Game: Player Instructions** and review the **Playing the Game: Activities Sheet** (allow four to five minutes).

6. Explain that they will have two "years" to accomplish objectives. Use the **Game Agenda (13-15)** transparency, and add *actual times* with transparency pen.

   Describe the Game board, pointing out that movement is from left to right, "Information" to "Routine Use." Explain that *shaded spaces are skipped*. Give the following instructions.

- Look at the **Playing the Game: Activities Sheet**. It represents all the possible moves in the Game. To do an activity, you must spend "bits" (or chips). You have 42 per team.
- Bits are equivalent to resources such as time, money, effort.
- Bits are replaced after "year one."

7. Refer to the **Playing the Game: Strategy Record Sheet** transparency (in Game box).

   - Instruct participants to look at the **Playing the Game: Strategy Record Sheet**. As a team, choose an activity; note there are "year one" and "year two" activities. The Game offers choices – as a player, you can affect what happens next.
   - Once your team decides on an activity, the team recorder puts a check in the box on the record sheet. Be sure to leave room for additional marks for repeated activities.
   - Keep track of StuBens (see *Leader's Manual* for description) and stages of people on record sheet.

   Using the transparency, model how the marks are made. Point out where social information and diagnosis of a district appear at the bottom of the record sheet. Point out monitors and explain that once an activity is selected and marked, the runner takes the **Playing the Game: Strategy Record Sheet** and the correct number of "bits" to the monitor, who will give the runner a card with further instructions.

8. Remind the group that "year one" ends at (note correct time, one hour from start). Also remind them that, like all simulation games, the Game becomes clearer as it proceeds.

   Remind teams to begin by reading the people cards – descriptions of the people on the board.

   Show the **Things to Remember (13-16)** transparency and leave posted.

9. After the Game has proceeded for one hour, stop the play and call attention. Using the **Scoring Check-In (13-17)** transparency, model the process for mid-point check-in by asking one team to volunteer:

BEST COPY AVAILABLE

- How many people do you have in each stage? Any StuBens?

Write the numbers given by the team on the overhead for people in the "Info," "Interest," and other stages. Point out where StuBens get recorded on the score sheet.

If there are no questions, direct each team to send one person to the scoring chart to record the numbers for his/her team. Take a "summer vacation" break. During the break, replenish the budget (bits) for each team.

10. Before beginning to play "year two," ask participants to study the filled-in **Scoring Check-In** transparency. What do they observe that reflects their experiences in "year one"? Then ask: What helped them make progress? What blocked progress?

11. Begin the play for "year two." In "year two," they have a new budget and are allowed to choose *any* activities from the **Activities Sheet**.

12. Play for 40 to 60 minutes, depending on time available. Then announce that the Game is over. Ask each team to send a representative to record results on the scoring chart in the "year two" space (bottom half of box) – number of people in stages and the final number of StuBens. While this is happening, ask the teams to discuss and list three to four key learnings from the Game.

13. After ten minutes, ask participants to look at the chart and share their observations of change from "year one" to "year two."

    - In "year one," many of the player pieces on the board are concentrated in the Information and Interest stages. By the end of "year two," if successful, there will be a majority of the pieces in Preparation, Early Use, and Routine Use stages.

    - The StuBens tally also increases greatly in the second year.

    - There are *always* people spread all over the board, even after two years.

14. Ask the group to share their discussions of what the Game illustrated about the change process. Use the following questions to probe further.

- What are your key learnings?
- What strategies worked for your team?
- What was frustrating? Why?
- If you were to play *Making Change* again, what, if anything, would you do differently?

15. Explain (or refer to one of their observations) that people react differently to change. Ask, for example:

    - Which people had moved farthest at the end of the Game?

      (Leaders: Eve, Jan, Nora, Upton; Innovators: Gary, Mia)

    - Which had moved least?

      (Resisters: Carol, Irene, Pat, Will)

    - Which people helped the most? Why?

      (From Social Info: Eve, Jan, Nora, Upton – brought their contacts along with them when they moved.)

    - What did you do that was successful in moving individuals?

      (Looked for those who seemed most interested; "talked to" and "talked to again" as many people as possible; involved those with social connections, etc.)

    - What factors do you think account for the fact that some people moved faster than others?

      (Different people have different reactions to new ideas, some go along with their friends, some take off with new ideas but don't influence others, some start slowly but speed up once they're started, etc.)

Introduce and discuss Adopter Types. Point out how individuals' personalities, experiences, and current circumstances affect how they will react to new ideas. Distribute the handout **Learning the Game: Adopter Types** and use the **Learning the Game: Adopter Types** transparency (in the Game box) to point out the *percentages* of the personality types in *typical groups/school districts.*

Ask:

- What overall strategies did you use – did you keep after the "movers and shakers" or did you keep trying to move the resisters?

  (Most effective for StuBens is to get a few people to Routine Use and leave Resisters behind.)

- How successful was your strategy? Why do you think it worked or didn't work based on the "Adopter Types" information?

Ask the group to suggest ways in which this "Adopter Type" information can be useful to them in their roles.

(For example, start with Leaders and Early Majority; it's important to know who influences whom; Innovators will probably come along on their own, though they can be encouraged, etc.)

16. *(Optional)* If participants are from the same school or district, ask them to take out a piece of paper and individually make a list of the innovators and leaders (key people) at their school or district that they might involve in their efforts – those who are open to change, are trusted by others on staff, have influence.

    After two to three minutes, ask for individuals to each share one name from their list and create a combined list on newsprint. Prompt people to add names. Suggest that someone from each group record the list for use at some later time.

17. Explain that they've been looking at *differences in individuals in how rapidly they adopt new programs.* They will now look at factors that are connected to *stages **most** people go through* in learning about using new programs and materials.

    Ask the group the following, and record their responses on newsprint:

    - Which activities were particularly successful in moving people into the information spaces on the board (first two columns)?

(Awareness into Information: Social information, "Talk to" [especially principals and Beth], "Talk to again," District diagnosis.)

- Which activities were particularly successful in moving people into the Interest spaces on the board? (Repeat question for Preparation and Early Use.)

  (Interest: Written information [twice is more successful than once], Materials display, Presentation to district [second is more successful].)

  (Preparation: Classroom lesson, Workshop: Activities, Follow-up help [if at least three people did classroom lesson], Support group.)

  (Early Use and beyond: Film fair, Theme week, Support group, Curriculum revision, Policy implementation.)

Note: If people have been sitting too long, you may want to structure this set of questions as a carousel brainstorming activity (see **Appendix B-2**).

Refer to the list of stages and strategies the group created above and ask:

- What factors do you think account for the fact that different activities worked better at different stages?

  (At Awareness and Information stages, "talk to" may have worked because people could ask questions, felt good about being contacted personally. District diagnosis helped team to know what people had already done; social information helped with who's connected to whom – both made the team more informed about where people were starting from, etc.)

- What did you learn about strategies for choosing activities?

  (You have to give people *information* about a program before they can be *interested*; "talking to" people is most effective to get their involvement early on; written information is effective only after you've talked to people a couple of times; you can waste money and time doing big events before enough people are involved in the project, etc.)

Affirm the group's conclusions and learnings. Distribute the handouts **Learning from the Game: Assumptions of the Concerns-Based Adoption Model (CBAM), Learning from the Game: Levels of Use of the Innovation**, and **Learning from the Game: Stages of Concern** and transparencies for each handout (in the Game box). Explain that the Levels of Use and Stages of Concern are part of the *Concerns-Based Adoption Model (CBAM)* (see **Activity 12: Understanding Change in Individuals: The Concerns-Based Adoption Model**, for more information), one of the pieces of research that forms the foundations for the Game. Review the chart and explain that this work defines the change process and demonstrates that an individual's feelings can and do change over time.

Ask the group:

- What new insights have emerged about how you design your reform efforts as a result of learning about Levels of Use and Stages of Concern?
- What would you do differently to:
  - generate ownership?
  - design professional development?
  - promote successful practices?

18. Ask the teams to look back at their lists of three to four key learnings. Have the teams (or individuals) share their items without repeating what another team (or individual) already said. Record on newsprint or transparency. After all teams (or individuals) have shared, acknowledge their answers. If necessary, add any learnings that were missed, using the handout **Learning from the Game: Learnings Built Into *Making Change***.

Additional References:

Crandall, David P.; Jeffrey W. Eiseman; and Karen Seashore Louis. Summer 1986. "Strategic Planning Issues That Bear on the Success of School Improvement Efforts." *Educational Administration Quarterly* 22 (3): 21-53.

Hord, Shirley M.;-William L. Rutherford; Leslie Huling-Austin; and Gene E. Hall. 1987. *Taking Charge of Change.* Alexandria, VA: Association for Supervision and Curriculum Development.

Loucks, Susan F., ed. November 1983. "Transplanting Success: Good News from a Study of School Improvement," theme issue of *Educational Leadership* 41 (3): 3-36.

Southwest Educational Development Laboratory. 1990-present. "Issues . . . about Change," a quarterly publication of the Southwest Educational Development Laboratory, Austin, TX.

ABOUT CHANGE

- Change is inevitable
- Everyone resists change
- You are important to successful change
- Change needs attention to be sustained
- The "Change Game" reinforces research-based change strategies

EXPECTED OUTCOMES OF THE GAME

- To understand the barriers to successfully implementing new programs
- To acquire strategies for creating effective change
- To learn to plan and manage change efforts
- To learn to work as a team to promote change

OBJECTIVES OF THE GAME

- To get educators and parents in "your" school district to support and implement equity in their work

  (i.e., move key people toward "Routine Use" on game board)

- To make changes that benefit students

  (i.e., collect "StuBens")

GAME AGENDA

Year One — 1 hour

Summer Vacation — 15 min. break

Check-in and Staff Development

Year Two — 1 hour

Debriefing

THINGS TO REMEMBER

- Identify a runner for your team
- Bring bits and Strategy Record Sheet to monitor
- Return cards to monitor when you are through with them
- Keep track of StuBens and the stages people are in on the Strategy Record Sheet

SCORING CHECK-IN

Team	Info	Interest	Prepara-tion	Early Use	Routine Use	StuBens
1						
2						
3						
4						
5						
6						

THE NAME OF THE GAME IS CHANGE

"Nothing endures except change."
Heraclitus

By John Rankin

While most people grudgingly accept this eternal verity, they know very little about the dynamics of change — how it happens, what makes it happen, why one program succeeds and another, perhaps better one, fails.

For some, change is an amorphous entity, like air or space, that goes unnoticed until there is something foul or threatening in it. These people will consistently resist anything other than the status quo.

Other people take a Field of Dreams approach — if they build it, change represents an outcome and almost anything is worth a try.

In between these two extremes are reformers who know that change is a process. They know that this process requires, among other things, ample amounts of team and consensus building, planning, staged actions, support, time, and persistence. In addition, they know that understanding the change process often spells the difference between reform success and failure.

Or do they?

Not according to researchers from The NETWORK in Andover, Massachusetts. Their work with school districts taught them that the best laid plans and most noble intentions of teachers and administrators are routinely sabotaged by a poor understanding of the dynamics of change.

"As we worked with... educators, we found that ideas that failed to take hold were often poorly introduced and rarely supported with training and other forms of assistance," said Leslie Hergert, a NETWORK researcher.

Rather than writing just another report on their findings, the researchers wanted something more simulating and interactive. Something that would help solve the problem. So they created a board game — *Making Change for School Improvement*.

"We saw in the game a unique tool for learning and professional development," said Hergert, who along with Susan Mundry, Frances Arick Kolb, Raymond Rose, and Jo Corro, developed the game. "While lectures and some other training experiences are very effective in providing awareness level information, many of these do not provide the opportunity for trial and error experimentation or safe environment for practicing new behaviors. Simulation activities, on the other hand, recreate real life situations."

And so that's what they build into the game — a place to practice the process of change, a place to sort through the maze of issues and concerns that often accompanies a project, and a place to learn the intricacies of building support for programs.

At a recent demonstration of the game in Washington, D.C., teams of three to five players assumed the role of a "change committee for educational equity" in the fictional Verifine School District. During the approximately four hours of play, the teams used familiar game paraphernalia — a game board, player "pieces," direction cards, resource tokens, and a record sheet — to advance a group of 24 district personnel through stages of school change in two years. Their ultimate goal was to bring about improved

BEST COPY AVAILABLE

education for the students.

As the players moved through the simulation, they began to see the complexity of the change process. Their recognition directly relates to three strands of educational research on which the game is based. The first defines how personalities affect the adoption of new ideas.

Making Change uses five "adopter types" to demonstrate how people differ in their readiness to accept change. These adopter types include: Innovators, eager to try new ideas; Leaders, open to change but more thoughtful; Early Majority, cautious and deliberate; Late Majority, skeptical of new ideas and intransigent; and Resisters, suspicious and generally opposed to new ideas.

Alethea Frazier, Staff Development Specialist for the Maryland State Department of Education, has used *Making Change* frequently over the past three years with principals, central office staff, and other staff developers. "I think there's some kind of immediate connection with the whole notion of adopter types," she said. "Those who play the game begin to understand intuitively who are the resisters and who is making the change effort move forward."

As they got to know the adopter types, players in this session saw how the way new ideas were introduced and supported influenced how well the ideas or change was implemented. This led them directly to the next strand of research incorporated into the game — the Concerns Based Adoption Model (CBAM). This research makes four assumptions about change:

- it's a process, not an event;
- it's made by individuals first, then institutions;
- it's a highly personal experience; and
- it entails developmental growth in knowledge, skills, and feelings.

According to Hergert, the game really starts with "getting people to talk and to understand the Concerns Based Adoption Model. Basically, what CBAM says is that people go through various levels of use in the implementation of innovations, and as they go through those levels, their concerns change. People need to understand that change is not a static situation. It's flexible and evolving."

Feedback helped players keep track of this evolution throughout the game. Game "monitors" provided players with feedback cards, which reported their successes, prompted them where to move game pieces based on their success, and awarded them StuBens (student benefits — the ultimate goal of change).

Monitors also instructed teams to choose a "chance card" when they decided to hold a board meeting, workshop, or make a presentation. According to the game's developers, "It is important for the players to learn that no matter how well planned something might be, there is still the element of chance to contend with."

The third strand of research forms the basis for the game's activities. This research is on the kinds of support needed in every phase of the change process in schools, and includes:

- the approval of the administration;
- broad support from the school and its community;
- staff development before, during, and after the change initiative; and
- institutionalization — writing the reform into the curriculum, the budget, or the school's policies to sustain the innovation.

Players do well in the game when their strategy incorporates these support requirements. For example, during this game, players found it necessary to conduct district-wide activities such as presentations and to distribute written materials. To do so, they first had to talk to the assistant superintendent not once, but twice. The first discussion made the administrator aware. The second discussion was necessary to develop the support necessary to get permission for the activities.

Unlike other commercial games, *Making Change* has no finale or defined end because it's a simulation based on real life. However, during debriefing sessions after the game, players were challenged to confront and dispel some of their previous notions about effective ways of managing school change. Some said they felt "frustrated" by the number of obstacles that surfaced during the game.

"Everything I experienced today, I have experienced one time or another in my job," noted Judy Mark, a curriculum specialist for the Baltimore County Public Schools. "Yet, this has been a rewarding experience. It's opened my eyes as to how to foster change."

Although *Making Change* has been in use for three years, the data on its impact on improvement efforts in local school districts are largely anecdotal. "Because it's a product now, we can't see the results," says Hergert. "But we know that school administrators often use it at the beginning of the change process. They tell us that the game has helped to inform their decision making."

Ultimately, Hergert hopes that Making Change will find its way into all school districts grappling with change. "I really think all teams responsible for school improvement, whether it's school-based management or school restructuring, could benefit from the game," Hergert says. "It's a very active process."

* * *

"Making Change for School Improvement" is available from The NETWORK, Inc., 300 Brickstone Square, Suite 900, Andover, MA 01810; (508) 470-1080; FAX (508) 475-9220. One set, which includes three game boards and player pieces, leader's manual, player instructions, and handouts, costs $240 (cite Publication #521-FY). The game can also be rented for $75 per week for each set (cite Publication #5220FY).

Reprinted with permission of the Council for Educational Development and Research from R&D Preview by John Rankin. 1993, 4-5.

14

ORGANIZATIONAL SUPPORT FOR SCIENCE AND MATHEMATICS EDUCATION

Audience:

- Individuals responsible for designing and supporting change in science and mathematics education at all levels.

Desired Outcomes for Participants:

- To identify the kinds of support that can help teachers and schools to improve their science and mathematics programs.

Materials:

- **Transparencies:**
  - *Room Diagrams* (14-5 and 14-6)
  - *The Interview Design Process* (14-7)
- **Handouts:**
  - *The Interview Design Process* (14-8 through 14-14)
  - *Interview Design Process: Questions A-H* (14-15 through 4-22)
  - *Finding Major Themes: A Guide for Analyzing the Qualitative Data* (14-23)
  - *Building a Pool of Organizational Support Strategies* (14-24)
- **Reading:**
  - "Provide Teachers with Adequate Support to Implement Good Science Programs," Chapter 13 of *Elementary School Science for the '90s*, by Susan Loucks-Horsley et al. Andover, MA: The NETWORK, Inc., and Alexandria, VA: Association for Supervision and Curriculum Development, 1990, 141-157.
- Overhead projector, screen, blank transparencies, and overhead pens
- Newsprint, easel, markers, tape, and pens or pencils

Time Required: Two hours

Facilitator's Notes: In order for science and mathematics programs to be improved and then maintained, the school and district need to provide support. But "support" is a very vague term that needs to be translated into action by many people for many different purposes. The school and district need to be goal-directed, nurturing organizations; teachers need moral and material support; everyone needs to take on some of the roles of change agents.

This activity suggests two different ways to draw on the experiences and expertise of participants to assemble a set of strategies for organizational support of science and mathematics programs. The first way is a staff development strategy called the Interview Design Process (Process Steps 1 through 6), which can be used to gather and analyze a large amount of information for many different purposes. The second way, the Brainstorm and Analysis Process (Process Steps 7 through 12), is done in a large group and results in quantitative data about favorite support strategies.

Note: The questions constructed for this activity focus on the "what" of support: What roles different people play, what kinds of support are needed, etc. If you think your group knows these things and is ready to share strategies for making such support happen (i.e., the "how" of support), you may want to reword the questions. For example, add to Question 1, "How can you work with principals to take on these roles?"

Process: INTERVIEW DESIGN PROCESS

1. Before the session, study carefully the handout **The Interview Design Process (14-8 through 14-14).** There are eight questions (although you can choose not to use all of them), so decide how many participants will be given each question and how many rows there will be. You may want to use the **Room Diagrams (14-5 and 14-6)** transparencies, or draw a diagram of your own to use as a transparency.

2. Describe the purpose of the exercise and then use **The Interview Design Process** (14-7) transparency to explain the Interview Design Process.

   Note: Instead of using *lines* of interviewers and interviewees, yet another alternative (for Step 3B in the handout) is to arrange interview *circles*. Arrange an even number of participants in concentric circle pairs, with the inner set of chairs facing outward and matched one-to-one to the outer set of chairs. Space the inner set of chairs far enough apart (make large enough inner ring) so that someone may walk between each adjoining pair of inner chairs. This allows lively discussion to proceed without overwhelming neighbors. The position of the inner and outer chairs encourages "knee-to-knee" interaction between questioning pairs. This can be done as one giant ring, or as several separate rings, configured similarly to your lines.

Distribute the full handout **Interview Design Process (14-8 through 14-14)**. Display the **Room Diagrams (14-5 and 14-6)** transparencies, or use your own diagram of the room arrangement. Have participants move chairs to match it.

According to the letters in the diagrams, distribute one question to each person from the handout set **Interview Design Process: Questions A-H (14-15 through 4-22)**. Begin the process, giving participants three minutes for each interview. After pairs have had a chance to interview each other, indicate that every other row should move one seat to the left. Continue until the process is completed.

3. Ask participants to join others with the same question and analyze and synthesize the responses on newsprint to report to the entire group. To help with this process, you may want to distribute:

   - the handout **Finding Major Themes: A Guide for Analyzing the Qualitative Data (14-23)**, if you think it appropriate;

   - the chapter from *Elementary School Science for the '90s* and suggest they skim it for additional ideas to add to their lists; and

   - the handout **Building a Pool of Organizational Support Strategies (14-24)**.

4. Ask each group to discuss how their synthesis fits with their definition of systemic change. Allow 30 minutes.

5. Ask groups to report out both their synthesis and its relationship to systemic change. After each group reports, give other participants an opportunity to ask questions and add their own ideas.

6. Ask participants to reflect on, talk about, and/or write: What have I learned in this activity? How can I use what I've learned?

BRAINSTORM AND ANALYSIS PROCESS

7. Divide participants into eight groups. Ask each group to select a recorder/reporter and brainstorm answers to the questions posed on the handout **Building a Pool of Organizational Support Strategies (14-24)**. Post their responses around the room.

8. Assign the groups one question each and have them collect the answers for their question from brainstormed lists from the other groups. The group task is to cluster the responses for their questions into a manageable number of categories (six to ten). Provide each group with a blank transparency to record the resulting categories. Allow 20 minutes to complete the task.

9. Ask groups to report out their categories.

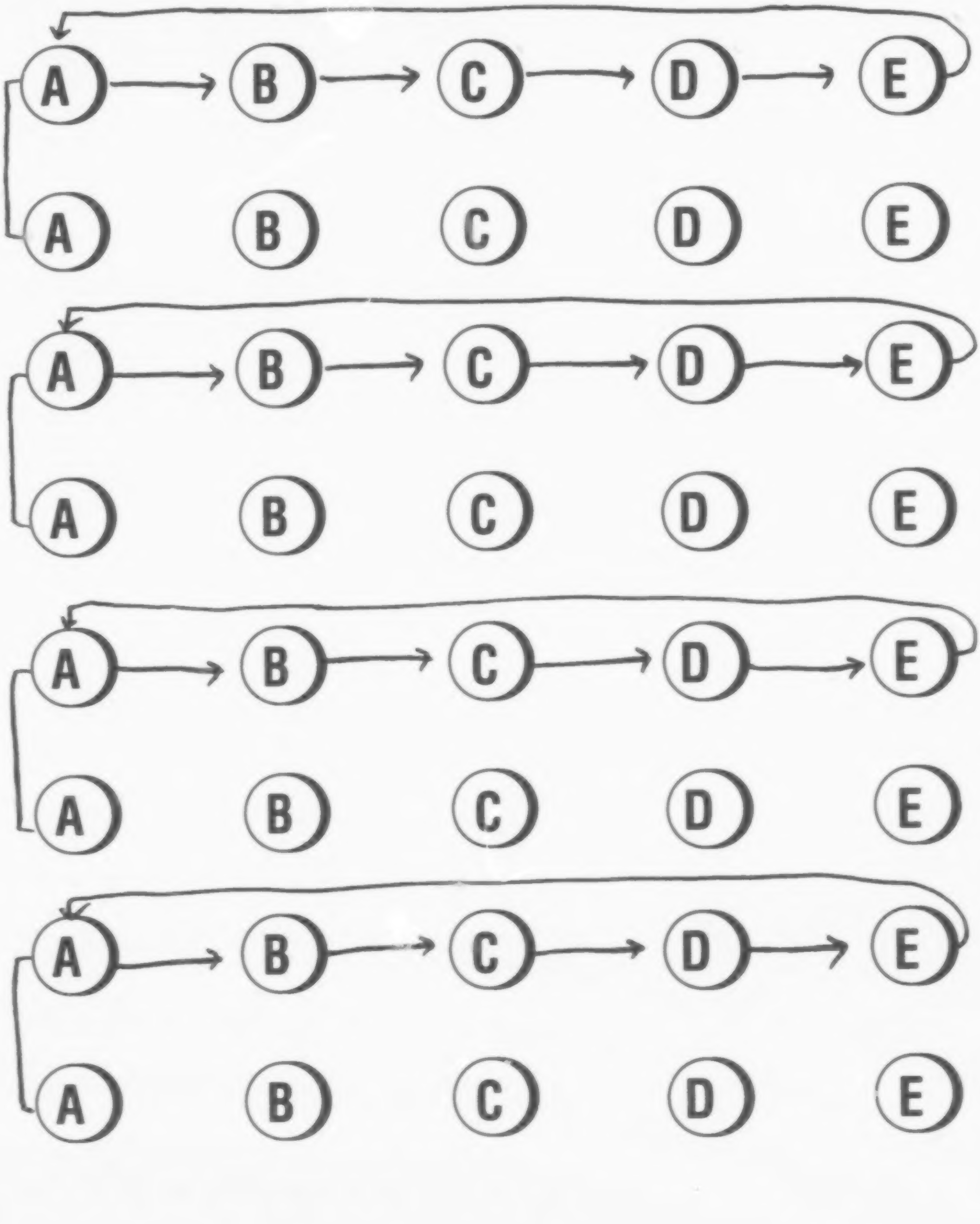
10. As each group reports out the recorder/reporter asks all participants to register the extent to which they agree with the importance of each category by raising their hands. Use a 1 to 5 scale with (1) being "strongly disagree" and (5) being "strongly agree."

11. After all groups have called for a rating by participants of their categories, ask them to go back into their groups. Have them tally the numerical data to identify those support categories and strategies on which there is the most agreement. Have each group report out.

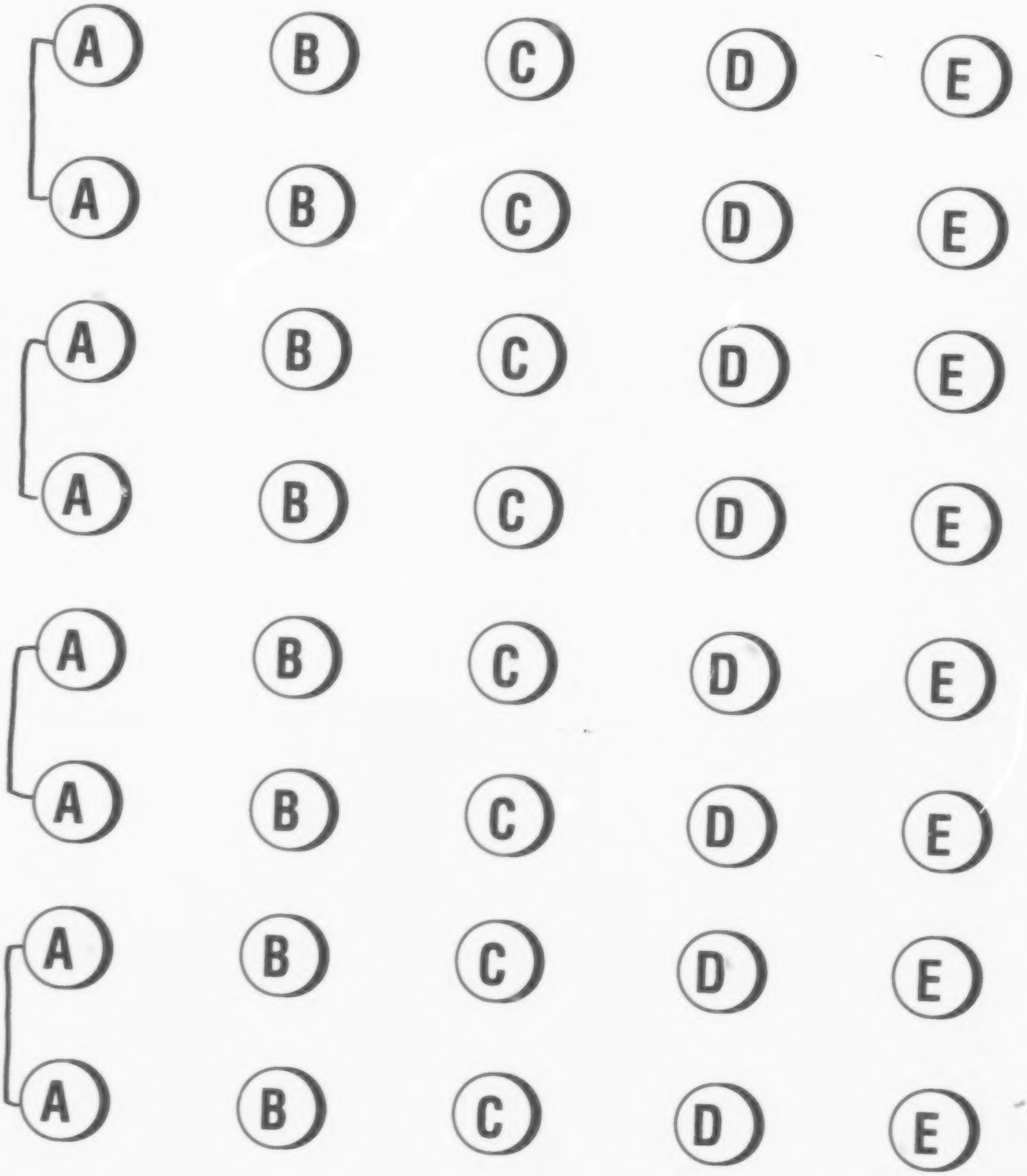
12. Ask participants to go back into their groups and focus on their original question assignments. Ask them to discuss how the results of the activity fit with their definitions of systemic change which they generated in **Activity 1: Framing the Dialogue Around Systemic Change**. Have each group report out their most important insights.

Additional Reference: Miles, Matthew B. and A. Michael Huberman. 1984. *Qualitative Data Analysis: A Sourcebook of New Methods*. Newbury Park, CA: Sage Publications.

ROOM DIAGRAM "A"


A
B
C
D
E
A
B
C
D
E
A
B
C
D
E
A
B
C
D
E
A
B
C
D
E
A
B
C
D
E
A
B
C
D
E
A
B
C
D
E

ROOM DIAGRAM "B"


A B C D E
A B C D E
A B C D E
A B C D E
A B C D E
A B C D E
A B C D E
A B C D E

THE INTERVIEW DESIGN PROCESS

1. Develop the questions
2. Prepare the interview sheet
3. Facilitate interview process
    a. Consider group size
    b. Arrange interview lines
    c. Distribute question sheets
    d. Start the interview
4. Analyze the data
5. Report

THE INTERVIEW DESIGN PROCESS

The Wharton School
Management and Behavioral Science Center

Purpose:

1. To generate and analyze information on a number of questions at once.
2. To balance and increase participation in identifying information, analyzing, and reporting conclusions.

Summary:

It is usually difficult to quickly gather information from a group in a conference or workshop setting. The Interview Design Process provides a process in which everyone participates in both asking questions and analyzing responses. The interaction is lively with people getting to know each other in a less superficial way than simple introductions. The quality of the information generated is surprisingly good, so substantive issues can be addressed if so desired.

Process:

Small or large group information and analysis process.

TIME
Ten questions will take one and one-half to two hours. The time is dependent on the number of questions used in the interview. Although interview time does not increase significantly with larger groups, more time must be allowed for analysis as the work group gets larger.

NUMBER
Groups of 16 to 100 members, depending on the number of questions.

The Interview Design is a powerful way for a group to generate and analyze information on a limited number of key questions. It encourages interaction, warms a group up, and gives much richer data than questionnaires. Furthermore, the participants identify the information as *their* information because they participated in the asking, giving, analyzing, and reporting phases. Therefore, it serves as an excellent data base on which to build problem-solving sessions.

Source: Reprinted with permission of Appalachia Educational Laboratory from *Targets for Trainers* developed by Dr. Jackie Walsh and sponsored by Kentucky LEAD Center. ©1992.

THE INTERVIEW DESIGN PROCESS (continued)

Some of the features of the interview design are the following:

1. *Active involvement*: All participants have to be actively involved, reporting answers and asking questions. No one is able simply to sit back and listen. Everyone talking at once creates excitement and energy.
2. *Anonymity*: All answers are recorded anonymously so that each person's opinion will be given equal consideration regardless of his or her role or position in the organization. It levels hierarchy and mixes "in groups" and "out groups". It is very effective with mixed groups (professional-lay, provider-consumer, adult-juvenile, etc.).
3. *Candor*: When people talk in pairs, they tend to be more open and honest. In larger groups they become overly concerned about what others think. Peer pressure and superiority cannot operate.
4. *Informality*: Participants have the opportunity to meet and talk privately with their colleagues, some of whom they may not have known. The exercise helps people get to know one another around a substantive exchange, rather than just names and positions.
5. *Objectivity*: The interviewer can only ask clarifying questions about his or her opinions and is not permitted to argue or contest responses. Likewise, the spokespersons in the group summaries are not allowed to let their own opinions influence their reporting. Thus, the design seeks objectivity as it casts the participants in the role of social scientists gathering data.
6. *Involvement in analysis*: Instead of outside experts analyzing data, participants experience the difficulty of consolidating the data to a few key points and must confront the diversity of viewpoints.
7. *Exposure to ideas*: Participants ask questions, listen to responses rather than argue, ask more questions to fully understand answers, and when the data are fed back, become exposed to the opinions, perceptions, and concerns of their peers. This enables them to relate their own ideas to those of their co-workers.

Process:

Step 1: Develop the Questions

The questions are usually developed beforehand, either from prior interviews with prospective participants or by workshop planners, to elicit information on questions of relevance to the goals of the workshop. A good interview design question should require

THE INTERVIEW DESIGN PROCESS (continued)

some thought and reflection and direct the respondent to organize their experiences into some useful categories. It is often helpful to ask for a specific number of ideas. Some typical questions follow:

1. Can you identify two or three ways in which your relationships with your superiors are similar to how you, in turn, relate to your subordinates? Can you identify several differences?

2. What are the three greatest barriers you face in your organization in getting one of your ideas accepted and implemented?

3. What are your goals and expectations for the workshop? What may inhibit your achieving these goals?

4. What do you feel will be the greatest changes in your field in the next twenty years?

As the questions illustrate, they can cover substantive ideas (#4), workshop goals (#3), management issues (#1), or change issues (#2). One concern should be to develop a set of questions of similar complexity so that they can be answered in the 3 to 5 minutes allotted. The set should explore different issues.

Regarding the number of questions, we feel 6 to 12 is the appropriate range, so that the interviewing process and reporting does not take too much time (1 to 1-1/2 hours). It is always helpful to have a few more questions than you plan to use, in case there are more participants than anticipated.

Step 2: Prepare Interview Sheet

To prepare for the workshop, each question should be typed at the top of an Interview Sheet and as many sets made as there will be interview lines. (See Step 3-C, Distribute Question Sheets.) Instructions on how to use the questions should be at the top of each page.

Step 3: Facilitate Interview Process

A. Consider the Size of the Group

The Interview Process can be used with groups as small as 16 (8 questions, 2 lines, 2 individuals doing analysis), on up to 100 (10 questions, 10 lines, 10 individuals doing the analysis). Note that the time does not increase significantly with larger groups. The interviewing depends on the number of questions, not the group size, and the

THE INTERVIEW DESIGN PROCESS (continued)

presentations are also no longer for big groups. You do need to allow more time for analysis as the work group gets larger.

B. Arrange Interview Lines

Arranging the interview lines appears complicated and will often create some anxiety among participants. It is usually sufficient to tell people something like the following:

"For the next one to one and one-half hours we would like to engage in an interviewing process that enables the group to meet one another and develop a lot of information on some key questions. We will give further instructions as we go along."

The most difficult aspect of Interview Design is arranging the interview lines. For groups divisible by four, it is easy, as illustrated below:

Size	*Possible Configurations*	*# of Questions*
20	2 lines of 10, 4 lines of 5	10 or 5
24	4 lines of 6, or 2 of 12	6 or 12
28	4 lines of 7	7
32	4 lines of 8	8
36	4 lines of 9	9

One trick to deal with uneven numbers is to have an extra pair on one line, and they will only have two in their analysis group. Alternatively, two individuals can sit together at the end of one of the lines that is not moving and conduct the interviews jointly. This is a useful way to integrate newcomers by placing them with someone at the end. The arranging is difficult to describe, and it is best simply to try it and develop different ways of handling various groups. Diagramming can help the facilitator work it out. (See Start the Interview, on the next page.)

It is worth noting that it is important to have the full group there on time. Sometimes it is useful to begin with some other short activity – such as workshop goal setting – to wait until all are there. It is a powerful beginning because once under way, people cannot duck out without leaving a visible gap in the interview chain.

THE INTERVIEW DESIGN PROCESS (continued)

C. Distribute Question Sheets

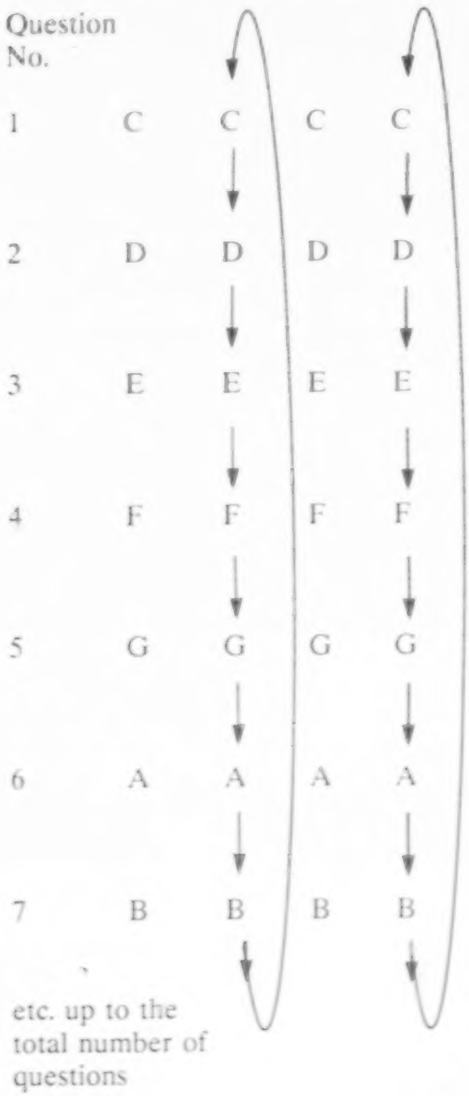
After the rows are formed, pass out the question sheets, one per person, with a full set in each row. It is usually better to wait until the group settles before giving further instructions. After people are in position and have the question sheets, you might ask people to read over their questions and clarify questions as necessary. At this point, it is useful to reiterate the instructions at the top of the question, stressing their role of listening and understanding. You might mention that they will be responsible for analyzing and reporting *accurately* the views of others after the interviewing phase.

D. Start the Interview

People are now ready to begin interviewing. It does not matter who begins. The following chart and description give an idea of the seating and movement of participants in the interview process.

THE INTERVIEW DESIGN PROCESS (continued)

Seating Arrangement for Interview Design



1. During the first interview, each asks the other the same question. Each will have three to five minutes to interview the other. It is usually helpful to allow a bit more time for the first pair than the others. The facilitator should listen and watch for signs that a pair has completed both interviews to see if the time is either too long or too short and adjust accordingly. After three to five minutes have elapsed, the facilitator should announce that the pair should switch roles, if they have not already done so.

2. After the full time (six to ten minutes), the facilitator should designate one line in each group to *move* one seat to the left so that everyone will be facing a new individual with a new question, although they will still be asking the same question. The individual at the end seat walks around to be at the front seat.

3. The facilitator repeats Steps 1 and 2 until either everyone has responded to all questions or until people seem tired. Ideally, the interview process continues so that each person is asked all of the questions. It usually will take about one hour for ten questions. Often, if time is getting short or you sense the participants are restless, you can stop after five or so rounds and still have considerable data for analysis.

THE INTERVIEW DESIGN PROCESS (continued)

Step 4: Analyze the Data

After the interviewing, all those individuals who were *asking* the same question assemble and compare their responses. Without overly emphasizing their own views, they should try to identify the major themes. If the question asks for three or four ideas, they should strive to identify the top six rather than listing all responses. This keeps the reports brief. The worksheets can be collected for further analysis by workshop staff for those ideas that are insightful but were not mentioned by enough others. After the analysis, each group should write their question on the top of a flip chart and the response below. This phase takes from 10 to 20 minutes, depending on the numbers in the group.

Step 5: Report

Each group should report briefly, perhaps two to three minutes. Questions can be held until the end or taken after each report as long as the discussion does not get out of hand. The charts can be typed and distributed as a quick record of the key points. The sheets can be used throughout the rest of the workshop as background data.

INTERVIEW DESIGN PROCESS: QUESTION A

Directions: Using the question below, interview the person across from you. Record the responses in the space under the question and on the back of the page. You will have three minutes to conduct each interview. You will be interviewing each individual in the line that you are facing. Record each individual's responses even if they are the same as someone else's. Record each respondent's ideas, not your interpretation. Reread the question to a given respondent as needed.

QUESTION A: What roles can principals play in supporting improvement in science and mathematics programs?

INTERVIEW DESIGN PROCESS: QUESTION B

Directions: Using the question below, interview the person across from you. Record the responses in the space under the question and on the back of the page. You will have three minutes to conduct each interview. You will be interviewing each individual in the line that you are facing. Record each individual's responses even if they are the same as someone else's. Record each respondent's ideas, not your interpretation. Reread the question to a given respondent as needed.

QUESTION B: What roles can teacher leaders and/or department chairs play in supporting improvement in science and mathematics programs?

INTERVIEW DESIGN PROCESS: QUESTION C

Directions: Using the question below, interview the person across from you. Record the responses in the space under the question and on the back of the page. You will have three minutes to conduct each interview. You will be interviewing each individual in the line that you are facing. Record each individual's responses even if they are the same as someone else's. Record each respondent's ideas, not your interpretation. Reread the question to a given respondent as needed.

QUESTION C: What roles can central office, curriculum, or science and mathematics supervisors play in supporting improvement in science and mathematics programs?

INTERVIEW DESIGN PROCESS: QUESTION D

Directions: Using the question below, interview the person across from you. Record the responses in the space under the question and on the back of the page. You will have three minutes to conduct each interview. You will be interviewing each individual in the line that you are facing. Record each individual's responses even if they are the same as someone else's. Record each respondent's ideas, not your interpretation. Reread the question to a given respondent as needed.

QUESTION D: What are some strategies for finding more time for teachers and others to participate in science and mathematics improvement activities?

INTERVIEW DESIGN PROCESS: QUESTION E

Directions: Using the question below, interview the person across from you. Record the responses in the space under the question and on the back of the page. You will have three minutes to conduct each interview. You will be interviewing each individual in the line that you are facing. Record each individual's responses even if they are the same as someone else's. Record each respondent's ideas, not your interpretation. Reread the question to a given respondent as needed.

QUESTION E: What barriers block or inhibit science and mathematics improvement and what is a strategy to deal with each one of them?

INTERVIEW DESIGN PROCESS: QUESTION F

Directions: Using the question below, interview the person across from you. Record the responses in the space under the question and on the back of the page. You will have three minutes to conduct each interview. You will be interviewing each individual in the line that you are facing. Record each individual's responses even if they are the same as someone else's. Record each respondent's ideas, not your interpretation. Reread the question to a given respondent as needed.

QUESTION F: What are characteristics or components of an ideal material support system to ensure that teachers have the equipment and materials they need to teach science and mathematics?

INTERVIEW DESIGN PROCESS: QUESTION G

Directions: Using the question below, interview the person across from you. Record the responses in the space under the question and on the back of the page. You will have three minutes to conduct each interview. You will be interviewing each individual in the line that you are facing. Record each individual's responses even if they are the same as someone else's. Record each respondent's ideas, not your interpretation. Reread the question to a given respondent as needed.

QUESTION G: How can the community enhance school science and mathematics programs?

INTERVIEW DESIGN PROCESS: QUESTION H

Directions: Using the question below, interview the person across from you. Record the responses in the space under the question and on the back of the page. You will have three minutes to conduct each interview. You will be interviewing each individual in the line that you are facing. Record each individual's responses even if they are the same as someone else's. Record each respondent's ideas, not your interpretation. Reread the question to a given respondent as needed.

QUESTION H: What characteristics of a school environment are necessary to support excellent science and mathematics programs?

FINDING MAJOR THEMES: A GUIDE FOR ANALYZING THE QUALITATIVE DATA

Introduction

In any qualitative research the analysis is of words, not numbers. The problem in such analysis is that words usually have multiple meanings. This makes them harder to move around and work with. A second problem involved in the analysis of words is that they are meaningless unless you look backward or forward to other words. Numbers, by contrast, are usually less ambiguous and may be processed with more economy. Small wonder, then, that most researchers prefer working with numbers alone, or getting the words they collect translated into numbers as quickly as possible.

Despite all this, words render more meaning than numbers and should be hung onto throughout data analysis. Converting words into numbers, then tossing away the words, gets a researcher into all kinds of mischief.

Coding

A common solution for analyzing words is coding. In this exercise, we are coding interviews by finding the major "themes" in our interview. These themes are categories. Such categories are usually derived from the questions, hypotheses, or key concepts. They are retrieval and organizing devices that allow the analyst to spot quickly, pull out, and then cluster all the segments relating to the particular question, hypothesis, concept, or theme. Clustering sets the stage for analysis. For example, the analyst may find it possible to apply a single summarizing notation to a sentence or paragraph such as motivation. Motivation would appear in the left-hand margin beside the segment. If the analyst wanted a little more differentiation, he or she might separate teachers' motivations from the administrators'.

Creating Codes

One method for creating themes is to begin a start list of themes prior to the interview. The list comes from the conceptual framework, list of questions, hypothesis, or problem area. There are at least two other methods of generating themes. In the first, interviews are coded after they are held. This method is more open and context-sensitive. A second alternative is to create a general accounting scheme for codes that is not content-specific but points to the general domains in which themes may be found. Some examples include acts or actions, activities, meanings, participation, relationships, and/or settings.

Whether themes are prespecified or developed along the way, make sure you have clear definitions so that they can be applied consistently. This type of coding is descriptive. It does not entail interpretation, but simply the attribution of a class of phenomena to a segment of text.

Source: Miles, Matthew B. and A. Michael Huberman. 1984. *Qualitative Data Analysis: A Sourcebook of New Methods*. Newbury Park, CA: Sage Publications.

BUILDING A POOL OF ORGANIZATIONAL SUPPORT STRATEGIES

Interview Design Questions:

A. What roles can principals play in supporting improvement in science and mathematics programs?

B. What roles can teacher leaders and/or department chairs play in supporting improvement in science and mathematics programs?

C. What roles can central office, curriculum, or science and mathematics supervisors play in supporting improvement in science and mathematics programs?

D. What are some strategies for finding more time for teachers and others to participate in science and mathematics improvement activities?

E. What barriers block or inhibit science and mathematics improvement and what is a strategy to deal with each one of them?

F. What are characteristics or components of an ideal material support system to ensure that teachers have the equipment and materials they need to teach science and mathematics?

G. How can the community enhance school science and mathematics programs?

H. What characteristics of a school environment are necessary to support excellent science and mathematics programs?

Reprinted with permission of The NETWORK, Inc. from Elementary School Science for the '90s by Susan Loucks-Horsley, et al. (c) 1990, 141-157.

13.

Provide Teachers with Adequate Support to Implement Good Science Programs

Science programs won't move very far off the launch pad if encouragement and the tools of the trade are missing. The best science teaching occurs when teachers have the organizational, psychological, and material support needed to do their jobs well.

WHAT WE KNOW

In Chapters 11 and 12 we explore the types of teacher development activities that prepare teachers to teach science well. Yet even well-prepared teachers need additional supports in the areas of organizational structure, materials management, and psychological nourishment that sustain the belief that science is indeed valuable and they can do a good job teaching it. Before we examine these supports, let's look at the **current conditions that inhibit elementary teachers from teaching science well** (Weiss 1987). They include:

- The uncertainty with which most teachers approach teaching science;
- The emphasis in elementary schools on language development and math, and the lack of attention given to science;
- The lack of a well-defined elementary science program with all the curriculum and support materials needed for the instruction of good science lessons;
- The lack of a well-planned staff development program geared to the improvement of science teaching; and
- Teachers' feelings of not being appreciated, of being isolated, and of being out of control regarding decisions about how best to teach the children for whom they are responsible.

Many of these issues can be addressed by taking a critical look at the organizational structures and supports (or lack thereof) in schools. It's critical that these systems work for teachers because, **of all the factors involved in the teaching of science, the most important is the classroom teacher.** Teachers need to be valued in demonstrable ways. In the business world, for instance, it is known that valued workers are more productive. This is no different for teachers. They are critical to their students' success.

There is little definitive research on how organizational structures influence the quality of science teaching. But we do have documentation on educational quality, teacher professionalism, policy implementation, effective schools, and educational change—all of which are directly related to the issue of teacher competency. This research suggests that high-quality education occurs in environments in which teachers are supported in five important ways:

1. **Clear purposes and outcomes.** Expectations for program goals and outcomes help teachers stay on course and move together in a productive direction. Standards of excellence for curriculum, instruction, and assessment should all be articulated. Who should establish program goals and outcomes? Though several national frameworks exist (AAAS's Project 2061 and the National Center's work are two examples), states may provide the most appropriate direction given their control over so many of the variables that can enhance or detract from good science teaching. In states with a history of local control, or that do not possess a goal-setting capacity, districts can set purposes and outcomes for science learning.

2. Resources and their allocation. What happens in the elementary classroom is directly influenced by available resources, time, and staffing. To adequately prepare students to become scientifically literate, students need to spend between 120 (K-3) and 300 (4-6) minutes per week on science and technology education. Right now, students are spending only 100 minutes or less per week learning science. We therefore need to make science a priority by allocating more time for science education. And to make that time worthwhile, there needs to be additional attention to staff development, adequate materials and equipment, and adequate facilities; these factors contribute to good science teaching, and all will require more resources.

3. A rich conception of staff development. Our new vision of exemplary science education requires a comprehensive teacher development strategy that continually confronts a complex range of issues linked to the district's overall goals and priorities (Odden and Marsh 1988). Disconnected staff development offerings will need to be replaced with an orchestrated set of courses that tie together state, district, and local frameworks for curriculum, instruction, and assessment. Involving groups of teachers or, better yet, all teachers within a school, in the same training, constitutes a critical mass that can help changes get implemented and then maintained. State and district science leaders as well as principals and other administrators can benefit from leadership development efforts. They can learn the delicate balance between alternately doling out support and applying appropriate pressure to struggling staff members.

4. Organizational norms that support constructivist learning. The constructivist science that we propose in this book requires that the classroom become a place for experimentation, risk taking, questioning, and collaborative problem solving. This can evoke more than a small amount of anxiety for many teachers. But if schools encourage and expect teachers to engage in these behaviors, the chance that they will develop their science teaching skills becomes much greater.

5. Involvement in decision making. Teachers who are knowledgeable and skilled in the teaching of constructivist science are in the best position to decide what should be taught and when. Clearly, they know their students better than anyone, and they need autonomy to make critical decisions, adjusting instruction to students' developmental needs, current understandings, and interests. We know from research that involvement in decision making can heighten teachers' ownership in their programs (Lightfoot 1983) and even reduce absenteeism and teacher turnover (Darling-Hammond 1986).

This is not to suggest that individual teachers should have total autonomy over their students' science education. For one thing, most elementary teachers are *not* skilled in teaching constructivist science, nor are they committed to doing so. Typically, elementary teachers are better prepared in and favor the areas of language arts and reading. Further, teachers have neither the time nor the expertise (nor, oftentimes, the interest) in determining scope and sequence for their grade level, for their elementary schools, or for their district's K-12 science education program. Nor are they up to date on what makes good science curriculum and instruction and what materials and programs are available to support them.

That said, teachers can and should help make decisions about science programs and curriculum, especially decisions that directly affect their students. Involvement of teachers on committees and task forces is critical if these decisions are to result in doable programs. At the school and grade or teaching team level, teachers can make program implementation decisions, including how and when to introduce new curriculums, how best to structure and deliver staff development, who should be teaching what, how teachers can support each other's teaching, and what special adaptations are needed for their students. Such decision-making prerogatives not only build ownership in teachers, but also the commitment to develop their own knowledge and skills to improve their teaching.

TAKING ACTION ON WHAT WE KNOW

Organizational Support

District and building administrators can demonstrate organizational support for teachers by sending a clear message that the elementary science program is a priority and by articulating clear expectations, purposes, and outcomes for the program. There is general consensus that people are more productive in their work environments when they know the what, how, and why of the structure, practices, and parameters within which they operate. For example, teachers can be more productive if they know which organizing principles the curriculum is built on and what instructional model supports the chosen principles. The development of clear purposes and outcomes helps teachers gain a sharp focus on the common agenda.

Organizational support should also include **actions by principals and others responsible for science education that help elementary teachers in their efforts to teach good science**. For instance, administrators can:

- Stop a teacher in the hall and ask how his science unit is progressing, what kinds of questions the students are asking, or what type of investigations they are developing;
- Provide teachers with information about science opportunities, such as new programs, conferences, meetings, and inservice workshops, and make funds or substitutes available so teachers can participate in pairs or teams;
- Create opportunities for teachers to share what they learn through both outside activities and their own experimentation;
- Take over a class for teachers so that they can coach their peers, team teach, or observe exemplary science teaching;
- Advocate science education by keeping the media aware of exciting things that are happening in the classrooms;
- Provide teachers with a petty cash fund for science activities;
- Organize a science field trip for teachers on a Saturday, and make it fun and exciting;
- Start some faculty meetings with a short, engaging science activity;
- Arrange for local scientists or science teachers to make presentations to classes;
- Arrange to have student presentations of science activities featured at a P.T.A. meeting;
- Support teachers in extracurricular science activity projects such as Invent America!, science olympiads, or energy fairs;
- Make it clear that science teaching (and the mess that goes with it) takes precedence over the needs of the custodians; and
- Nominate leading teachers for the new Elementary School Presidential Awards in science.

Figure 13.1
Roles for Principals

(Adapted from Mechling and Oliver 1983)

Here are some important roles for principals:

- *The principal as science leader:* Principals demonstrate leadership in and positive attitudes toward science education and communicate their interest in science to teachers and others.
- *The principal as curriculum analyst:* Principals investigate their own science programs in terms of goals, teaching strategies, typical learning experiences, evaluation procedures, and so on.
- *The principal as a force in the selection or development of a new science curriculum:* Principals provide leadership in curriculum choice or development. As a driving force and catalyst, they push to get the process going and keep it on track.
- *The principal as provider of the wherewithal:* Principals seek funds to purchase science supplies and equipment, cover costs of staff development, and ensure that supplies are readily available for teacher use.
- *The principal as provider of inservice instruction:* Principals take the lead in providing inservice experiences in science for their teachers.
- *The principal as a monitor of progress in science programs:* Principals give their science programs periodic checkups to determine their validity and continuing effectiveness.
- *The principal as troubleshooter:* Principals deal effectively with problems that arise in the science curriculum, like teachers having difficulty fitting science into their crowded day, over-reliance on reading as a method of teaching science, classroom noise, and inconvenient schedules or access to materials or equipment.

Administrators can help teachers become competent decision makers by creating opportunities and structures in which they can become involved in decisions about implementing curriculum, instruction, and teacher development. For example, teachers should be given a chance to collaborate on their own professional development. They should be provided opportunities to share expertise, coach their peers, solve problems, and pursue their own improvement. Time and settings can be arranged for them to share their knowledge about how students learn, what teaching approaches work in different areas of science and technology education, and what topics and themes might be appropriate vehicles for teaching the major concepts, skills, and attitudes that we recommended earlier in this book. A climate that communicates that everyone has something to learn and that everyone can benefit from others' experience is essential.

Funds for teacher release time can be (re)allocated for staff development by:

- Establishing more personal professional days;
- Arranging for roving substitute teachers to release teachers for an hour of peer observation, team planning, and so on;
- Specifying early release days on a regular basis;
- Hiring teachers with expertise on an extended contract for work in the summer with district personnel and principals; and
- Combining several classes to release teachers.

Teachers who demonstrate excellence in teaching constructivist science should serve as workshop planners and leaders and demonstrate classroom teaching. They should plan for teacher development by working with district personnel, board members, principals, peers, and the community. Administrators can showcase lead teachers by recommending them to the state for recognition, using them as key committee members, and publicly recognizing their expertise.

Teachers should be systematically rewarded for good science teaching and an ongoing commitment to their own learning. Both external and intrinsic rewards are appropriate motivators for teachers to continue their professional development. Effective staff development systems provide a variety of options for rewards: additional pay and opportunities to train others, to travel, and to work collaboratively. Intrinsic rewards are probably even more powerful. The opportunities we have listed above should spur teachers to share ideas; reach out for innovative, effective teaching practices; and increase the knowledge of their craft. It's highly rewarding and motivating when a teacher masters a new teaching strategy and then goes on to become a teacher of teachers. Such personal success reaffirms the belief that one can make a difference in the lives of children as well as adults.

Psychological Support

Teachers feel supported in environments that champion openness and have norms that encourage them to be experimenters, risk takers, and team players. Doing science is a way of knowing about the world around us. In the elementary grades, good science teaching encourages students to wonder, to explore, and to develop conceptions of how the world works. To teach science effectively, teachers need the license to investigate, try new ways of doing things, and work with others to share and solve problems. Strategies that help teachers themselves become science students will effectively support science education.

Psychological support is also demonstrated when teachers feel that their concerns and needs are being taken care of. In Chapter 10, we describe seven stages of concern that can be used to monitor changes in how teachers feel about their science programs. These stages are also useful to pinpoint teachers' needs and questions so they can be responded to. For example, when teachers have management concerns, they can use help with making better use of time, getting and organizing materials, and managing classroom activities. Since it's possible to predict how concerns will change over time, one can design an implementation effort that addresses teachers' needs as they emerge through materials, workshops, in-class assistance, and so on. It's usually a relief to teachers when administrators assure them that change takes time and perfect performance is not expected overnight. Being sympathetic to individual concerns and having the right kind of help available when it's needed are what we mean by psychological support.

Material Support

To teach science well and avoid frustration, teachers need appropriate and easily accessible resources. Needed support includes providing materials for teaching, creating an environment that sustains a constructivist science program, allowing time to prepare for teaching good science, and considering options for teacher assistance, like having a science resource teacher available. Consider implementing one or more of the following ideas:

1. **A resource list**, perhaps taken from the National Science Resources Center's (1989) *Science for Children: Resources for Teachers*, of curriculum and material vendors, publishers, and distributors, complete with addresses, phone numbers, and prices. The resources selected should reflect program goals. The list must be

easily accessible (e.g., included in curriculum guides or the like) and be updated yearly.

2. An in-house news vehicle such as a newsletter or electronic mail. This can serve several important functions: to announce workshops and new resources; to organize for materials management; to create opportunities for teachers and others to share ideas; and to alert people to relevant current events, problems, and so on.

3. **An organizing system for media resources** (e.g., films, videos, computer software) that are used in the science program. A list of all items used by grade level in the program is essential. Additionally, a "prepare ahead of time" list can help with teacher preparation and organization. The title, order number, and location (central distribution media center, school media center, individual kits) all need to be clear and accurate. A budget that provides for adequate copies of any one title ensures that use will occur at the best learning point for students instead of whenever the title is available.

4. A system of storage and retrieval for all printed materials that includes information on when and how to use them and where to get supplementary resources if they are not provided. One person in charge (teacher, media specialist, principal, district person) prepares and monitors an inventory that is ready, appropriate, and available for use. Laissez-faire or honor system approaches often lead to disappearing materials and a greater drain of funds.

5. A system for purchasing, packaging, storing, and replenishing hands-on science materials. Considerations for such a system include:

- *Reusable materials* that can be recycled for a number of years if not broken or lost. Kits need good packaging if they are going to last. When purchasing a program, examine its packaging; do not accept inadequate materials. If packaging your own kits, buy the best boxes possible.
- *Storage areas* in each building or central to the district. These need to be sufficient to prevent teachers from getting damaged test tubes, shattered light sources, and crushed materials boxes.
- *A retrieval/inventory system* handled by one individual. The program will not be taught if materials are not complete, easy to assemble and get, or damaged. Inventory lists, including the

number of each item per classroom, are needed on all kits at the beginning of each unit in the curriculum guide.

- *Consumable materials* need to:
  - —be listed by unit *and* by all units for the year in curriculum guides;
  - —have local sources identified;
  - —be budgeted for each year, with yearly totals given to the principal for budget planning; and
  - —have a replenishment system in which teachers know who buys, with what money, on what person's request, with how much lead time, and so on.

Each district and school is responsible for deciding how to best manage science equipment and materials. A materials support system helps make science instruction easier. When organized at the school level, the librarian might house and manage the materials. Or one teacher or a school secretary might assume the responsibility for ordering, storing, and disseminating materials, when provided the time to do so.

A districtwide system for materials management is most cost-effective. This may involve a central science kit system or science center where supplies of commercial kits or locally developed materials and other items are stored and resupplied. This allows for bulk purchasing and sharing of equipment and supplies. Sharing materials will mean a wider range of units available for students. Another advantage of establishing a science center is that it serves as a tangible focal point of the elementary science program for teachers, administrators, and the community, thereby promoting science education. Materials such as posters available from the U.S. Forest Service, to be used by a large number of teachers, would have a home in the science center. Through such a centralized system, districts can maximize working with private industry to develop materials and kits for units like mining and minerals. A well-organized central program in which staff routinely update materials and sign out materials systematically can go far to optimize the use of resources for science teaching. (For examples of such systems, see the Models and Resources section.)

ONE PLAN OF ACTION

There are many possible ways to begin to design or overhaul an elementary school science program. Under Local Roles and

State Roles, we describe many starting points for and components of long-term change. Here, however, is one quick start-up strategy for a district that wants to start tomorrow to make a difference in science learning. This strategy includes:

1. **A shared leadership team of selected teachers and administrators** who assess the current state of science teaching and resources, select a science program, oversee training and support for teachers, monitor progress, and communicate regularly both inside the system and with the community.

2. **An existing, exemplary science program** selected from among those recognized by NSTA in its Focus on Excellence Program, the National Diffusion Network, or those described in the National Science Resources Center's (1989) *Science for Children: Resources for Teachers* (see Models and Resources section for more information), and adapted for use with the particular student population and resource base.

3. **A set of pilot teachers** who, with help from the program's developer, spend a year mastering the program and being prepared as a *training and support cadre* for full implementation.

4. **A two-year training sequence for all**, with the first year having up to three days of release-time workshops in which teachers learn how to teach the units, and with the second year having up to three days devoted to improving teachers' understanding and skills in constructivist teaching, cooperative learning, and approaches to assessment.

5. **A support structure** that provides teachers with all the materials they need for teaching and makes individual help and coaching available to them on a regular basis.

6. **A program of awareness and training for people other than teachers** (such as principals, library and media specialists, and resource teachers) to orient them to the new program, how it relates to other programs, and the support roles they need to play.

Others may want to begin their efforts to improve support for science teaching in different ways. Below are some roles that local and state educators can use to begin on the road to long-term change.

LOCAL ROLES

1. **Carefully plan and develop an elementary science curriculum**. Specify what is to be taught, the strategies to be used,

and the time frame for teaching the curriculum. Include on the development committee teachers who, although they may not be expert science teachers, recognize the importance of teaching science well. Also include principals and district administrators. Consider exemplary district programs, programs from the National Diffusion Network, and curriculum currently under development for adoption or adaptation. Review materials, make visits, and try out sample units to help make a decision.

2. **Develop policies and procedures, and articulate them to teachers**. Clearly defined procedures help to ensure that staff members will be treated fairly and equally. Trust is fostered when teachers know what to expect and what is expected of them.

3. **Plan for and implement a materials management system**. Design a system appropriate to the schools' and district's resources, science curriculum, and staff capabilities.

4. **Recognize the principal's role in supporting an elementary science program**. Provide principals with special training in that role, including enough about the curriculum and instructional strategies for them to recognize it in classrooms and help teachers find help if they need it. Encourage principals to allow for release time through schedule manipulations and to set a climate that includes the expectation, encouragement, and praise for teachers to teach science well. Principals can encourage staff members to share their knowledge and experience by inviting them to form collegial teams, recommending that they take lead roles on district committees, and involving them in decisions about implementing the science curriculum.

5. **Promote collaboration as a means of personal support for teachers**. Provide opportunities for teachers to work together as they try new activities and solve problems as they arise. Encourage or require teams of teachers (or teachers and administrators) to attend the same inservice programs so that whole groups of teachers have similar orientations and experiences.

6. **Provide leadership in making teachers comfortable in their roles as experimenters, risk takers, and team players**. Provide support for alternative teaching strategies, give encouragement rather than criticism when activities fail, and make time for educators to meet in groups to develop cooperative and team efforts.

STATE ROLES

1. **Make routine budget allocations and press for additional funds for staff development to support good science teaching.** Pay special attention to the training of those responsible for science education in districts, with the expectation that they will create similar opportunities for their teachers and administrators.

2. **Communicate with local administrators and others responsible for science education about the availability of federal funds** that are allocated exclusively to improve K-12 science and mathematics teaching. Encourage local educators to use these pass-through monies in ways that will enhance psychological, material, and structural supports for teachers.

3. **Ensure that all state frameworks and guidelines justify and support constructivist science** as described in this book. It is often more convincing when classroom or district personnel can cite an authoritative source to justify a particular approach to teaching.

4. **Develop and support regional science education networks within your state** where teachers and others can periodically gather to discuss problems and new strategies. Select topics of particular interest to elementary teachers, such as innovative curriculum materials or understanding space probes.

5. **Explore networking via electronic communication.** With only a few current uses around the country, electronic communication holds promise for the future. The McGraw-Hill MIX system, for example, is popular with some states already developing statewide or regional bulletin boards.

6. **Create and present awards in a meaningful ceremony for exemplary science teaching at the elementary level, much as the Presidential Awards competition does.** In some states, the governor, the state commissioner of education, or the state board of education recognizes exemplary teachers. The National Science Foundation is awarding grants to K-12 teachers in each state for excellence and leadership in mathematics and science. State science personnel usually administer this program, with a substantial monetary award given to the finalist in each state. Consider developing a similar state program.

7. **Work with appropriate legislative bodies to pass legislation that affirms the need and value of elementary school science programs.** Included in such legislation could be provis-

ions for curriculum improvement, staff development, and release time for teachers and others to work together for self- and school improvement.

8. Disseminate media releases that reaffirm the research that thinking, reasoning teachers planning together provide a statewide basis for improving schools. Highlight efforts in which teachers are involved in meaningful ways to improve science programs in their buildings and districts. Focus attention on instances in which teachers share leadership in their schools and where science is a priority.

MODELS AND RESOURCES

A Resource Guide: *Science for Children: Resources for Teachers* is a publication of the National Science Resources Center (NSRC). The guide lists curriculum materials, supplementary materials, and sources of information and assistance that can be very helpful in supporting a constructivist-oriented science program. The NSRC also sponsors summer institutes for school district elementary science leadership teams.

A Source of Exemplary Programs: The National Science Teachers Association's Search for Excellence in Science Education Program has identified districts where strong teacher development and support systems are leading to effective science education in elementary schools. Descriptions of these programs are published periodically in the NSTA's (1985, 1988) Focus on Excellence Series. Examples of several support efforts are described below.

A Source of Exemplary Programs: The National Diffusion Network disseminates several exemplary elementary science programs, each with its own materials and teacher training and support components. Programs that support constructivist science include Conservation for Children (San Jose, California); Hands-On Elementary Science (Frederick, Maryland); Life Lab Science Program (Capitola, California); Marine Science Project: FOR SEA (Poulsbo, Washington); and STARWALK (Peoria, Illinois). (See Lewis 1988 for more on these innovative programs.)

A Resource for Principals: The National Science Teachers Association, with funding from NSF, is sponsoring a number of Regional Science Leadership centers across the country to support principals as leaders for science education. The PAL centers conduct two-day training sessions in which principals can learn about hands-on science, receive materials, and prepare to train and support teachers within their schools. The project, directed by Ken Mechling and Donna Oliver (1983), is located at Clarion State University in Pennsylvania.

A Material Support System Model: The elementary science program in Carroll County, Maryland, has a unique materials support model. Each spring, Carroll County teachers receive an order packet for science materials. The packet is set up as an inventory control vehicle for the kits, which house all the necessary materials for curriculum activities. (Early in the program, the science supervisor shopped for necessary curriculum materials. The contents of the Carroll County materials kits are now provided by a commercial vendor.) Principals have the responsibility of providing appropriate amounts of the cost-per-student allotment for science. If teachers do not have the necessary materials, the science supervisor is informed. Live materials for activities are provided in house. A high school science teacher works part time with student aides to maintain cultures and live specimens, providing them to elementary teachers as needed.

A Material Support System Model: In Anchorage, Alaska, more than 1,000 teachers in 55 schools get needed supplies for science from a central system that manages purchasing and dissemination of equipment and material supplies. Materials are circulated to teachers on a prearranged schedule. Early in the school year, teachers complete a form that alerts the science center to their needs. Teachers teach at least four science units a year—one hour a day, three days a week. Teachers are encouraged to use additional resources and develop interdisciplinary connections to the science unit. The materials for each unit are assembled into a kit at the science center and then delivered to the teachers as scheduled. The kits remain with each teacher for six weeks.

The center's staff orders and stores all materials needed to teach the units, assembles class-sized sets of materials; maintains a truck delivery route so that teachers receive materials when they need them; and inventories, cleans, and replenishes all materials when they are returned. This cost-effective sharing system allows for a wider range of units to be taught. Moreover, duplication of costly materials can be kept to a minimum. Another plus is that the science center serves as a concrete focal point for the elementary science program. Teachers, administrators, and the community have become aware of the strong science program in place and how it facilitates good science teaching.

A Material Support System Model: An example of a support system for teachers in a small, rural school is Westford Elementary School in northwestern Vermont. Two summers ago, the Parent Teachers Group (PTG) donated $2,000 to purchase supplies for the elementary science program. A committee of parents and teachers worked together to select and order basic materials for the classrooms. The principal offered support by locating a small, centrally located utility space to house the materials. Other townspeople helped by donating storage shelves for the space and by purchasing and labeling storage containers for the new materials.

The teachers use a simple sign-out system to keep track of the equipment. Volunteers inventory and help with the upkeep of the storage area. This year the PTG again donated money. Additional supplies, as well as science resource materials that will support teachers in implementing their newly adopted science curriculum, are being purchased. This is one example of science being widely supported in a small community.

An Association for Science Leaders: The Leadership Institute for Science Education (LISE) Center is a professional development and resource center of the National Science Supervisors Association (NSSA). Through a national cadre of trained science leaders, the LISE Center provides programs and resources to promote leadership development and teacher advocacy for science education. Among its services are institutes, conferences, seminars, and leadership publications.

Institutes for Science Leadership: The National Science Resources Center (NSRC) has a program of summer Elementary Science Leadership Institutes that prepare leadership teams—teachers, science supervisors, school system administrators, and scientists—to organize elementary science program improvement efforts for their local school districts.

A Model for Teachers Supporting Teachers: The PACT Program in Jefferson County Schools, Colorado, places teachers in the roles of university clinical faculty, mentors for beginning teachers, and instructors for district inservice activities. Exemplary classroom teachers are chosen by Metro State College, the University of Colorado at Denver, and the Jeffco School District for a one-year leave of absence. During that time, PACT teachers teach at the university and mentor two preservice teachers. They also conduct district inservices and consult with principals about curriculum and instructional issues.

Key References

Darling-Hammond, L. (1986). *A Conceptual Framework for Examining and Staffing Schooling*. Santa Monica, Calif.: RAND Corporation.

Hord, S. M., W. L. Rutherford, L. Huling-Austin, and G. E. Hall. (1987). *Taking Charge of Change*. Alexandria, Va.: ASCD.

Lewis, M. G. (1988). *Science Education Programs that Work*. Washington, D.C.: National Diffusion Network, Office of Educational Research and Improvement, U.S. Department of Education.

Lightfoot, S. L. (1983). *The Good High School: Portraits of Character and Culture*. New York: Basic Books.

Loucks-Horsley, S., M. Carlson, L. Brink, P. Horwitz, D. Marsh, H. Pratt, and K. Worth. (1989). *Developing and Supporting Teachers for Elementary School Science Education*. Andover, Mass.: The National Center for Improving Science Education, The NETWORK, Inc.

Loucks-Horsley, S., and L. F. Hergert. (1985). *An Action Guide to School Improvement*. Andover, Mass.: The NETWORK, Inc., and Alexandria, Va.: ASCD.

McLaughlin, M. W. (1987). "Learning from Experience: Lessons from Policy Implementation." *Educational Evaluation and Policy Analysis* 9, 2: 171-8.

Mechling, K. R., and D. L. Oliver. (1983). *Promoting Science Among Elementary School Principals*. Washington, D.C.: National Science Teachers Association.

National Science Resources Center. (1989). *Science for Children: Resources for Teachers*. Washington, D.C.: NSRC.

National Science Teachers Association. (1985). *Focus on Excellence Series*. Elementary: 1:2. Washington, D.C.: NSTA.

National Science Teachers Association. (1988). *Focus on Excellence Series*. Elementary: 4:3. Washington, D.C.: NSTA.

Odden, A., and D. Marsh. (April 1988). "How Comprehensive Reform Legislation Can Improve Secondary Schools." *Phi Delta Kappan* 69: 593-598.

Weiss, I. S. (1987). *Report of the 1985-1986 National Survey of Science and Mathematics Education*. Washington, D.C.: National Science Foundation.

603

15

BUILDING COLLABORATIVE TEAMS

Audience:

- Individuals responsible for designing and supporting change in science and mathematics at all levels.

Desired Outcomes for Participants:

- To use knowledge of the stages of team development and the roles of team members to improve the productivity of a team and the satisfaction of its members; to use a variety of strategies to assess team effectiveness.
- To define consensus and select from one of two ways for groups to attain it.
- To apply strategies for designing and conducting effective meetings.

Materials:

- **Transparencies:**
  - *Stages of Team Development* (15-9)
  - *Principles for Effective Teamwork* (15-10)
  - *Sabotaging the Team* (15-11)
  - *Group Task Behaviors and Roles* (15-12)
- **Handouts:**
  - *Team Development Wheel* (15-13)
  - *Stages of Team Development* (15-14 through 15-17)
  - *Principles for Effective Teamwork* (15-18)
  - *Sabotaging the Team* (15-19)
  - *Who Does What in Your Group?* (15-20)
  - *Group Task Behaviors and Roles* (15-21 and 15-22)
  - *Consensus* (15-23 and 15-24)
  - *The Nominal Group Process* (15-25 and 15-26)
  - *Strategies for Productive, Efficient Team Meetings* (15-27 through 15-31)
  - *Guidelines for Leadership in Small Groups* (15-32 and 15-33)
  - *Observer Guide* (15-34)
  - *Some Characteristic Behaviors Found in Productive Groups* (15-35 and 15-36)
  - *A Yardstick for Measuring the Growth of a Team* (15-37)
  - *How Are Our Team Meetings Going?* (15-38 and 15-39)
- Overhead projector, screen, blank transparencies, and overhead pens

- Newsprint, easel, markers, blank paper, 3" X 5" index cards, and pens or pencils

Time Required: Four to six hours

Facilitator's Notes: One of the key characteristics of systemic change is collaboration, often among organizations, agencies, and segments of the community that have never worked together before. Becoming a "learning organization" requires "team learning" – developing common understandings, supporting the growth of others, stretching, and experimenting together. For educators who have traditionally worked in isolation from other adults, teamwork skills have never been a requirement. That is why teams established for various purposes – more often as time goes by – often struggle to work effectively.

Facilitating systemic change in science and mathematics education requires an ability to work with and sometimes even form your own teams. The purpose of this activity is to help you move from a group of individuals into a productive team whose work together results in "more than the sum of its parts." There are several foci: to help people understand what it means to be a team and how they as individuals influence the team's effectiveness; to build skills in teaming, especially the all-important skill of decision making; and to develop a repertoire of strategies for conducting effective meetings and assessing team effectiveness.

You will want to pick and choose among the exercises that follow, depending on the stage of development of the group or team you are working with. These are meant to provide the "basic skills." Additional skills and understandings can be developed through use of the resources listed in the **Additional References** on page 15-8.

Process: STAGES OF TEAM DEVELOPMENT

1. Explain to participants that this activity is aimed at helping them increase the effectiveness of the teams they work on and with. To begin thinking about teamwork, ask participants to imagine they are writing a letter to someone who has just assumed the role of team leader for the first time. What would they put in the letter? After five minutes, ask them to break into groups of four to share their ideas.

2. Distribute the handout **Team Development Wheel (15-13)** to the groups. Ask participants to think about a team that they are now working on or with. Have them check off behaviors that they have experienced in the quadrant that seem to reflect the stage that they perceive their team to be in at this time.

3. If participants in a group are on the same team, ask them to compare their assessments and attempt to reach consensus on their stage of team development. **(If not, go to Step 6.)**

4. Ask the groups for a sampling of stages from the teams represented. Ask clarifying questions and check for understanding to assure accuracy. Using the handout **Stages of Team Development (15-14 through 15-17)** and the **Stages of Team Development (15-9)** transparency, review the stages.

5. Invite participants to reflect on the framework, their behaviors, and those of their colleagues. Ask them to discuss *implications* and develop a set of *action steps* they would like to implement in their work groups. Provide time for sharing of small group discussion ideas.

6. If participants are not from the same team, ask them to share in small groups where their teams currently are, using this framework. After reviewing the stages (Step 4), ask them to discuss what they think would be helpful to the different teams represented in the group. Ask them to report out their ideas for appropriate interventions for different stages. Compile a summary on newsprint.

TEAM ROLES AND FUNCTIONS

Principles for Effective Teamwork

7. Present and discuss concepts and ideas contained in the handout **Principles for Effective Teamwork (15-18)**. Use the **Principles for Effective Teamwork (15-10)** transparency to highlight the main ideas.

Negative Group Behaviors – Sabotaging the Team

8. Introduce this exercise by explaining that there are many reasons why individuals working collectively fail to work as a team and because of this often fail to accomplish a task. One is that individuals sometimes – either purposely or accidentally – are

preventing the team from working. This kind of sabotage can be accomplished in various ways.

At the top of a sheet of newsprint, write the heading, "Sabotaging the Team – Negative Group Behaviors." Invite participants to contribute to the list. Using the handout **Sabotaging the Team (15-19)**, supplement the newsprint list with any of the behaviors described in the handout that were not suggested by the group. Use the **Sabotaging the Team (15-11)** transparency or newsprint to highlight the main ideas.

9. For each of the negative group behaviors listed by participants, identify helpful interventions that have potential for reducing or eliminating the behaviors. Some examples are:

   - asking for feedback about an idea or principle
   - asking for more specific criticism or objections
   - describing specific behaviors without interpreting or judging
   - postponing a discussion until a time when people are less emotional and have more information, etc.
   - asking direct questions
   - expressing mixed feelings
   - stating intentions
   - sharing likes and dislikes
   - communicating wants and needs
   - listing options to choose from and choosing topics together
   - reflecting
   - validating others
   - discussing problem behavior during group process evaluations

Positive Group Task Behaviors and Roles

10. Introduce this exercise by encouraging participants to be aware that there are different roles they can play to help work go more smoothly. They should try to match their skills and talents to these roles, and encourage other team members to play these roles, and in so doing, help themselves and other members develop the team's productivity and effectiveness.

    Distribute the handout **Who Does What in Your Group? (15-20)** and have participants complete it for a group they are currently in. Display the **Group Task Behaviors and Roles (15-12)** transparency. Review and discuss the group task roles, referring to the handout and/or transparency.

Application Activity

11. These learnings can best be applied at some later time during an actual group discussion or team meeting. Put some or all of the group task roles on index cards, one per card. Distribute them to group members without their seeing each others' cards. Ask them to play that role during the ensuing discussion. After the discussion, ask them to identify who played what role and debrief the experience.

REACHING DECISIONS BY CONSENSUS

12. An easy way to introduce this exercise is to use the Pyramidal Process for Reaching Consensus (see **Appendix B-5**) to have participants develop their own definition of consensus. First, ask them to work in pairs on a definition. Then have two pairs combine to work on a common definition.

13. Distribute the handout **Consensus (15-23 and 15-24)**. Review the essential elements of consensus. Discuss the definition of consensus: what it means and does not mean, the advantages, and the nature of the "consensus contract."

14. Explain the Pyramidal Process for Reaching Consensus. Discuss the process and its purpose. Select an appropriate task and guide the group through the process. This process works well when developing a mission or philosophy statement.

15. Distribute the handout **The Nominal Group Process (15-25 and 15-26)**. Discuss the process and its purpose. Select an appropriate task and guide the group through the process. The process works well when arranging any list of items in priority order.

16. Whether you practice one or both of these techniques, end by asking the following questions:

    - What is the contribution of consensus decision making to systemic change?
    - What challenges do you anticipate/have you experienced?
    - What are ways of addressing those challenges?

CONDUCTING BETTER MEETINGS

Initiating, Conducting, and Participating

17. Introduce the concept of initiating, conducting, and participating in effective meetings as a leadership skill. It requires leadership to *initiate* a meeting – to bring people together to focus on a problem or to share information. It requires leadership to conduct a meeting – to move through the agenda items at a pace appropriate to the level of readiness exhibited by the group. It also requires leadership to *participate* in a meeting – to effectively engage people with ideas that enhance group productivity.

Pet Peeves and Missing Pieces

18. Ask participants to respond to the following questions:

    - How many of you have had to take the initiative in convening a meeting – perhaps composed of people who have not worked together before, or perhaps with your peers?
    - How many of you have had the responsibility of chairing a meeting from start to finish?
    - How many of you attend a meeting – either social or business
        - once a month?
        - once a week?
        - more than three times a week?

Ask participants to list their Pet Peeves or Missing Pieces on a piece of paper (or 3" X 5" index cards) based on their experiences with some of the meetings that came to mind in response to the above questions.

Ask participants to form small groups of three or four to develop a common list of key words and phrases from among the Pet Peeves and Missing Pieces.

Ask them to share a word or phrase from each group and record on newsprint.

Conducting Effective Meetings

19. Begin by asking participants to work in pairs and ask one to describe an effective meeting, the other a frustrating one.

    Distribute the handout **Strategies for Productive, Efficient Team Meetings (15-27 through 15-31)**. Ask participants to return to their small groups and consider their Pet Peeves. Which of these would some of the strategies alleviate?

    Have the large group discuss those Pet Peeves that are still unaddressed.

Guidelines for Leadership

20. Present and discuss concepts and ideas contained in the handout **Guidelines for Leadership in Small Groups (15-32 and 15-33)**. Use a blank transparency or newsprint to highlight the main ideas.

    Note: For point 6, an effective strategy to increase participation is to have group members discuss issues in smaller groups, e.g., in threes, and report out to the larger group.

ASSESSING TEAM EFFECTIVENESS

21. Distribute the handouts **Observer Guide (15-34), Some Characteristic Behaviors Found in Productive Groups (15-35 and 15-36), A Yardstick for Measuring the Growth of a Team (15-37),** and **How Are Your Team Meetings Going? (15-38 and 15-39)**. Offer these as tools to help them assess the effectiveness of their team(s).

22. Ask participants to comment on which of these they think would work for what purposes, for what kinds of teams, and for what stage of team development.

Additional References:

Arbuckle, Margaret A. and Lynn B. Murray. 1989. *Building Systems for Professional Growth: An Action Guide.* Andover, MA: The Regional Laboratory for Educational Improvement of the Northeast and Islands.

Hubbard, James; Manert Kennedy; John Sutton; and Sharon Trefny. 1994. *Dynamics of Alliances.* Aurora, CO: Mid-continent Regional Educational Laboratory.

Miller, Rima. 1987. *Team Planning for Educational Leaders.* Philadelphia: Research for Better Schools.

Patterson, Jerry L. 1993. *Leadership for Tomorrow's Schools.* Alexandria, VA: Association for Supervision and Curriculum Development.

STAGES OF TEAM DEVELOPMENT

FORMING
Dependent on leader
Concern about clarity of task

STORMING
Conflict with members, leader, and task

NORMING
Cohesiveness
Shifting leadership

PERFORMING
Interdependency
Creativity
High productivity

Source: *Building Systems for Professional Growth: An Action Guide* by Margaret A. Arbuckle and Lynn B. Murray. Andover, MA: The Regional Laboratory for Educational Improvement of the Northeast and Islands. ©1989, 4-11.

PRINCIPLES FOR EFFECTIVE TEAMWORK

- Responsibility for the team is shared by all members
- Decisions should always be agreed to by the team
- Use methods which encourage full participation
- Be flexible
- Cut down the threat to individual members
- Continually evaluate team progress
- Team members should be conscious of the importance of their roles

Source: Rima Miller, *Team Planning for Educational Leaders*, Research for Better Schools, Inc., ©1987, 9. Adapted with permission.

SABOTAGING THE TEAM

Blocking

Attacking

Being playful

Seeking recognition

Deserting

Pleading special interest

Dominating

Source: Rima Miller, *Team Planning for Educational Leaders*, Research for Better Schools, Inc., ©1987, 12-13. Adapted with permission.

GROUP TASK BEHAVIORS AND ROLES

Initiating

Information/opinion seeking

Information/opinion giving

Clarifying/elaborating

Summarizing

Setting objectives

Testing workability

Checking

Gatekeeping

Harmonizing

Relieving tensions

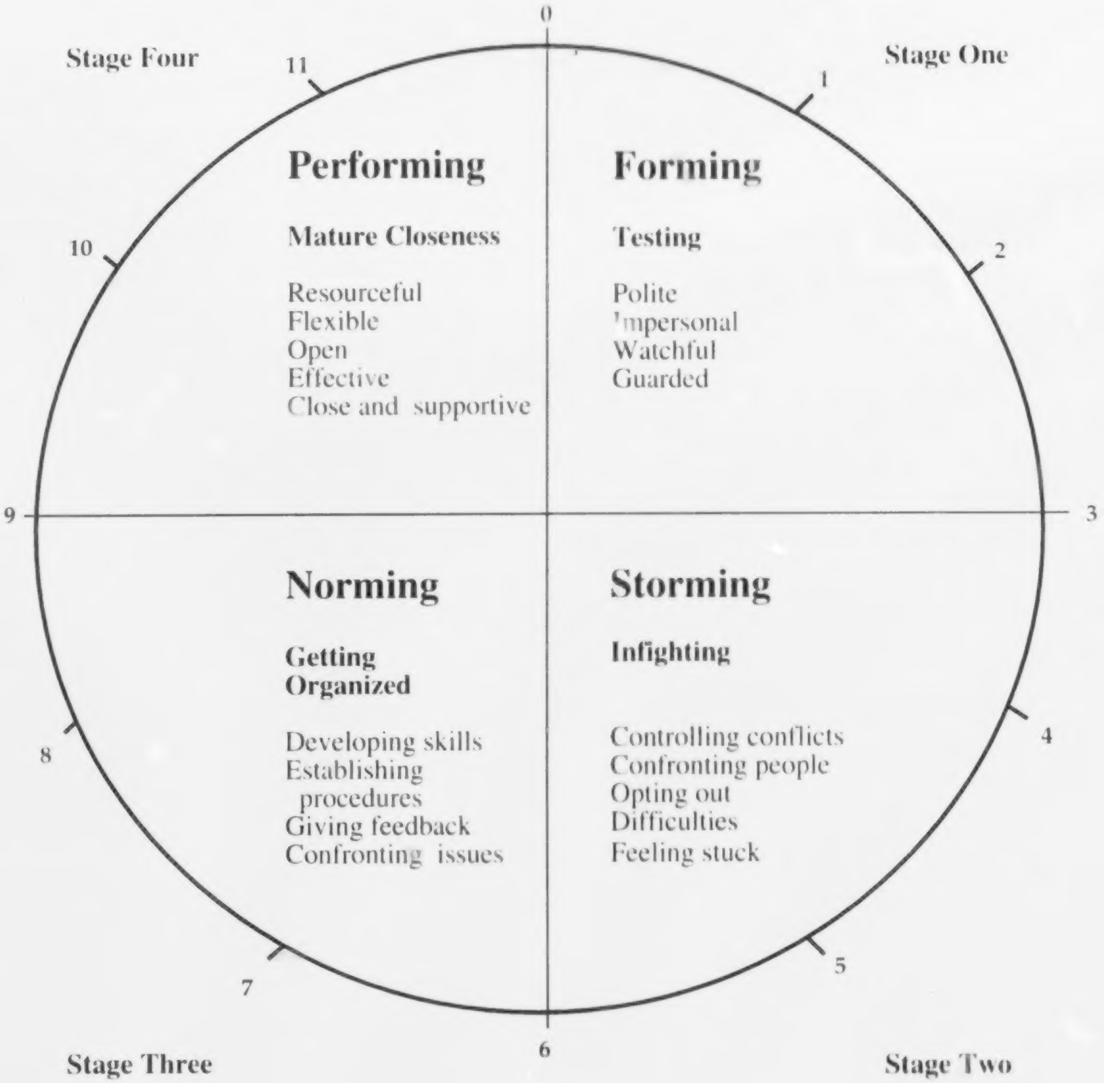
Encouraging

Diagnosing

Source: Rima Miller, *Team Planning for Educational Leaders*, Research for Better Schools, Inc., ©1987, 13-14. Adapted with permission.

TEAM DEVELOPMENT WHEEL

Instructions: Place a mark on the circumference of the wheel to represent the present status of your team.


0
Stage Four
11
Stage One
1
Performing
Mature Closeness
Resourceful
Flexible
Open
Effective
Close and supportive
Forming
Testing
Polite
Impersonal
Watchful
Guarded
10
2
9
3
Norming
Getting Organized
Developing skills
Establishing procedures
Giving feedback
Confronting issues
Storming
Infighting
Controlling conflicts
Confronting people
Opting out
Difficulties
Feeling stuck
8
4
7
5
6
Stage Three
Stage Two

Source: *Building Systems for Professional Growth: An Action Guide* by Margaret A. Arbuckle and Lynn B. Murray. Andover, MA: The Regional Laboratory for Educational Improvement of the Northeast and Islands. ©1989, 4-5.

STAGES OF TEAM DEVELOPMENT

Groups of people working together do not become a team in a day. Teams evolve and become productive over time. Regardless of their size or composition, teams go through certain stages of development. The length of each stage varies from team to team and may be as short as one meeting or may last for several months. The sequence of stages is the same for each, and while the specifics of each stage may vary from team to team, the overall nature of each stage is consistent across teams. During this process, some of the activities and feelings of team members may not appear to be productive. This is particularly true during the dissatisfaction stage when a sense of frustration and incompetence frequently emerges. However, working through each stage is a crucial part of the team's evolution if the end result is to be a fully functioning team.

1. Orientation Stage ⟹ Forming

- ■ Members are somewhat eager and have positive expectations.
- ■ Members are concerned about and want to know:
  - ☐ What is the purpose of the team?
  - ☐ What will they have to do?
  - ☐ Who will lead?
  - ☐ Will their efforts be fruitful?
- ■ Members are dependent on the situation and whoever is leading.
- ■ Energy and time are focused on:
  - ☐ Defining the goal(s) and the task of their team.
  - ☐ Devising at least an initial means for carrying out tasks, i.e., team process and procedures.

Source: *Building Systems for Professional Growth: An Action Guide* by Margaret A. Arbuckle and Lynn B. Murray. Andover, MA: The Regional Laboratory for Educational Improvement of the Northeast and Islands. ©1989, 4-7 through 4-9.

STAGES OF TEAM DEVELOPMENT (continued)

  - ☐ Determining what skills are needed for their team, which of those skills members lack and need to develop, and how those skills might be learned.
  - ☐ Once determined, trying out and becoming accustomed to team process and procedures.

2. **Dissatisfaction Stage ⟹ Storming**

- ■ Members become somewhat frustrated.
  - ☐ Expectations and reality of team work do not coincide.
  - ☐ Dependence on the leader becomes unsatisfying.
  - ☐ Appropriate resources are not readily available.
  - ☐ Some problems presented to team are not easily solved.
- ■ Members may feel some anger towards the leader, the goals and tasks of the team, and other members.
- ■ Members may feel sad or discouraged.
  - ☐ They feel they cannot do what they hoped.
  - ☐ They feel incompetent.
- ■ Energy and time are focused on:
  - ☐ Redefining what their task is in "achievable" terms.
  - ☐ Determining how best to accomplish their task, including assessing any additional skills needed.
  - ☐ Resolving their sense of frustration and incompetence.
  - ☐ Redefining their expectations so that they are more compatible with what is possible.

STAGES OF TEAM DEVELOPMENT (continued)

3. **Resolution Stage ⟹ Norming**

- Frustration is dissipating.
    - Expectations and reality are more closely, if not completely, meshed.
    - Skill in carrying out procedures and, therefore, in completing tasks is increased either by additional experiences with the process or specific training activities.
- Personal satisfaction is increasing.
    - Process and procedures are being mastered.
    - Self-esteem is heightened.
    - Pleasure in accomplishing task and getting positive feedback from staff through informal or formal monitoring processes outweigh earlier frustrations.
- Collaborative efforts are beginning to jell.

4. **Production Stage ⟹ Performing**

- Members are once again eager to be part of the team effort.
- Individuals on the team feel greater autonomy.
- Members are working well together.
    - Leadership functions are shared.
    - Sense of mutuality (we sink or swim together) and interdependence has developed.
- Energy and time are focused on achieving the team's purpose: meeting staff needs through strong professional development activities.

STAGES OF TEAM DEVELOPMENT (continued)

5. Termination

- Members may feel:
    - Sense of sadness because the team is, at least for the time being, ending.
    - Strong sense of accomplishment.
    - Last minute urgency to tie up loose ends.
    - Regret, if they feel they were not able to do everything planned.
- Energy focused on:
    - An evaluation of what has been accomplished, both quantity and quality.
    - What needs to be done to complete the task for the time being.
    - If appropriate, how to begin the task anew the following school year and what changes, if any, should be made based on the previous year's experience.

Major Messages:

1. Team evolves through several stages of development.
2. A stage may last for one hour or one year, and there is no way to know ahead of time how long a particular stage will last.
3. Dissatisfaction is a natural part of the team process and should not be viewed as a sign that the team is failing, but rather that it is time for the members to take stock and review goals, processes, resources, rewards, and outcomes.

PRINCIPLES FOR EFFECTIVE TEAMWORK

Although there are no recipes for being an effective team, there are some basic principles that can help team members work together efficiently and productively. Use these principles as guidelines for your team efforts. Feel free to adapt them, add to them, delete some, modify some, or make up new ones to suit your team and situation.

- *Responsibility for the team is shared by all team members.* Identify with the team and its goals – if the team fails, it's both your fault and the team's fault.
- *Decisions should always be agreed to by the team.* They are not made by the leaders, any individual, or any clique – all important policies should be decided by the team. The team should have a voice in its own goals and the techniques that should be used to accomplish them.
- *Use methods which allow as many as possible of the team members to participate.* Let the team work frequently in subgroups. Bring out minority and individual opinions by asking frequent questions of team members.
- *Be flexible.* Be flexible in rules, agenda, and in all procedures. Establish a plan for your activities, but always modify it when you find that you need to. Tasks and how they are done should change as the skills, needs, and interests of the team change.
- *Cut down the threat to individual members.* Get team members acquainted with each other. Use informal procedures, minimize rules, separate the members of cliques or friendship circles, discuss the problem of status, and use subgroups to get members accustomed to working as a team.
- *The team should continually evaluate its progress.* This may be done by evaluation sheets, process reports, subgroup discussions, suggestion boxes, etc. The important point is that it should be done often, briefly, and well.
- *Team members should be conscious of the importance of the roles that they play.* Study the different roles that people can play, analyze the roles they play, and consciously play roles that are helpful to team progress.
- *Let the team be active.* Let team members try a variety of tasks, encourage a risk-free atmosphere where no one fails, and consciously provide for the skill development and appropriate participation of all members.

Source: Rima Miller, *Team Planning for Educational Leaders*, Research for Better Schools, Inc., ©1987, 9. Adapted with permission.

SABOTAGING THE TEAM

Blocking:

- Being negative and stubbornly resistant
- Disagreeing and opposing without or beyond "reason"
- Attempting to maintain or bring back an issue, direction, or task after it has been rejected or bypassed

Attacking:

- Deflating the status of others
- Expressing disapproval of the values, acts, or feelings of others
- Attacking the team, the leader, or the problem being worked on
- Joking aggressively
- Trying to take credit for another's contribution

Being playful:

- Displaying lack of involvement in the team's efforts by cynicism, nonchalance, or horseplay

Seeking recognition:

- Boasting or reporting on personal achievements
- Acting in unusual ways
- Struggling to prevent being placed in an "inferior" position

Deserting:

- Withdrawing in some way
- Being indifferent, silent, aloof, excessively formal, or lost in day dreaming
- Deliberately doing tasks that are unrelated to team's functions and goals (e.g., grading papers, knitting)

Pleading special interests:

- Speaking for the "grass roots" and the "community," the "poor children," etc.
- Cloaking one's own prejudices and biases in the stereotype that best fits selfish, individual needs

Dominating:

- Asserting power or superiority to manipulate the team or certain members of the team by flattery
- Asserting a superior status or right to attention
- Giving directions autocratically
- Interrupting the contributions of others

Source: Rima Miller, *Team Planning for Educational Leaders*, Research for Better Schools, Inc. ©1987, 12-13. Adapted with permission.

WHO DOES WHAT IN YOUR GROUP?

Below is a list and a brief description of different roles and functions that people play in groups. First, assess your own behavior by indicating how often you perform each role (1 = rarely, 5 = all the time). Then choose the one person in the group who best fits each role description and write their name next to the role.

Group Task Roles	*Me*	*Others*
1. *Initiator/Contributor:* Proposes goals, ideas, solutions; defines problems, suggests procedures.	_____	___________
2. *Information and Opinion Seeker:* Asks for clarification and suggestions; looks for facts and feelings; solicits ideas and values of other members.	_____	___________
3. *Information Giver:* Offers facts and relevant information or experience.	_____	___________
4. *Opinion Giver:* States beliefs about alternatives; focuses on values rather than facts.	_____	___________
5. *Clarifier/Elaborator:* Interprets; gives examples; defines terms; clears up confusion or ambiguity.	_____	___________
6. *Coordinator/Summarizer:* Pulls ideas, opinions, and suggestions together; summarizes and restates; may try to draw members' activities together; offers conclusions.	_____	___________
7. *Gatekeeper/Expediter:* Keeps communication open to all members; opens up opportunities for others to participate.	_____	___________
8. *Harmonizer:* Tries to reduce conflict and tension; attempts to reconcile differences.	_____	___________
9. *Encourager:* Supportive of others; praises efforts and ideas; accepts contributions.	_____	___________
10. *Evaluator:* Helps group assess whether it has consensus or is reaching a conclusion.	_____	___________

Source: *Building Systems for Professional Growth: An Action Guide* by Margaret A. Arbuckle and Lynn B. Murray. Andover, MA: The Regional Laboratory for Educational Improvement of the Northeast and Islands. ©1989, 4-23.

GROUP TASK BEHAVIORS AND ROLES

Initiating:
- Helping the team get started by proposing tasks or goals
- Defining a problem
- Suggesting a procedure or idea for solving a problem

Information/option seeking:
- Requesting facts, asking for clarification of statements that have been made
- Trying to help the team find out what people think or feel about what is being done
- Seeking suggestions or ideas

Information/opinion giving:
- Offering facts or additional useful information
- Expressing thoughts or feelings
- Giving suggestions or ideas

Clarifying/elaborating:
- Interpreting or reflecting ideas and suggestions
- Clearing up points of confusion
- Offering examples to help the team imagine how a strategy or proposal might work
- Distinguishing alternatives to issue before the group

Summarizing:
- Pulling together related ideas or tasks
- Restating suggestions after a group has discussed them
- Organizing activities so that the group will know what it has accomplished

Setting objectives:
- Expressing objectives for the group to achieve
- Applying standards in evaluation
- Measuring accomplishments against goals

Testing workability:
- Applying suggestions to real situations to gauge the practicality and workability of strategies

Checking:
- Sending up "trial balloons" to see if the team is nearing completion of a task
- Checking to see how much more needs to be done

Source: Rima Miller, *Team Planning for Educational Leaders*, Research for Better Schools, Inc., ©1987, 13-14. Adapted with permission.

GROUP TASK BEHAVIORS AND ROLES (continued)

Gatekeeping:
- Attempting to keep communication channels open
- Making it possible for others to make their contributions
- Suggesting procedures for more productive use of resources

Harmonizing:
- Attempting to reconcile disagreements
- Trying to provide common-ground compromises for opposing points of view so the team can continue to work
- Getting people to explore their similarities, as well as their differences

Relieving tensions:
- Draining off negative feelings by jesting or soothing troubled people
- Putting tense situations in a wider context

Encouraging:
- Being friendly, warm, responsive to others and their contributions
- Helping others to contribute
- Listening with interest and concern
- Reinforcing others' participation

Diagnosing:
- Determining sources of difficulty
- Seeking appropriate next steps

CONSENSUS

Consensus Decision Making:

- Is a process used to ensure that every individual has input into a decision.
- Requires everyone's participation. Listening, sharing, trust, and respect are values inherent in the process.

The Consensus Contract:

Consensus is based on the term "to consent" as in "to grant permission." To arrive at consensus is to give permission to go along with the total group (the majority). The implication of consensus is that an individual can negotiate the terms by which he or she will grant his or her permission. Each individual has the right and obligation to make his or her terms known.

Contract Assumptions	**Commitments/Procedures**
All people are choosing beings.	I will explain my perception of the problem/issue.
All persons are free to disagree and voice an opinion.	I will discuss my feelings.
Freedom means he/she engages in action by choice.	I will explain my needs/goals concerning the issues.
Compromise is not necessary.	I will let others know how important this issue is to me.
There is no right answer.	I will listen to others' opinions.
	I will respect others' needs for space, privacy, and identity.
	I will negotiate.
	I will grant permission to the majority, with a minority report.
	I will implement the decision.

Source: *Building Systems for Professional Growth: An Action Guide* by Margaret A. Arbuckle and Lynn B. Murray. Andover, MA: The Regional Laboratory for Educational Improvement of the Northeast and Islands. ©1989, 4-33 through 4-34.

CONSENSUS (continued)

Advantages of a Consensus:

Unlike a majority vote, a consensus requires a full commitment from all the group members to the decision. Because everyone is involved in the decision and must indicate agreement, the outcome is likely to be accepted by most.

(If there is a vote, members in the minority are often not given an opportunity to propose changes, and if they vote NO, they are in effect relieved of any responsibility for the outcome.)

Consensus may take a bit more time in a group, but the outcome is usually more likely to be implemented and supported. It's worth the effort.

Consensus Means . . .	**Consensus Does NOT Mean . . .**
All group members contribute.	A unanimous vote.
Everyone's opinions are heard and encouraged.	The result is everyone's first choice.
Differences are viewed as helpful.	Everyone agrees (there may be only enough support for the decision to be carried out).
Everyone can paraphrase the issue.	Conflict or resistance will be overcome immediately.
Everyone has a chance to express feelings about the issue.	
Those who disagree indicate a willingness to experiment for a certain period of time.	
All members share the final decision.	
All members agree to take responsibility for implementing the final decision.	

THE NOMINAL GROUP PROCESS

The nominal group process is a method for structuring groups to allow individual judgments to be pooled and used when there is uncertainty or disagreement about the nature of the problem and possible solutions. The process is helpful in identifying problems, exploring solutions, and establishing priorities. It works best with groups of five to nine participants. Larger groups can be handled by making minor changes in procedure, particularly Step 2, but any group larger than 12 should be subdivided.

Nominal Group Process Procedures

Step 1: Silent generation of ideas in writing.

Read the focus question aloud and ask participants to list their responses in phrases or brief sentences. Request that they work silently and independently. Allow four to eight minutes.

Step 2: Round-robin recording of ideas.

Go around the table and get one idea from each participant. Write the ideas on newsprint. As each sheet is finished, tape it on the wall so that the entire list is visible. Number each item. Leave space to the left of each number to record votes at a later time. Encourage hitchhiking on other ideas. Discourage discussion, elaboration, or justification.

Step 3: Serial discussion of the list of ideas.

Clarification: Explain that the purpose of this step is clarification. Read item 1 aloud and invite clarifying comments. Then read item 2 and continue discussing each item in turn until the list is covered. Arguments are unnecessary because each participant will have a chance to vote independently in Step 4. As soon as the logic and meaning of the item are clear, cut off discussion.

Categorizing: Once each item has been discussed, duplicate items should be identified and combined. This may necessitate rewriting some of the items before the voting step. However, resist the temptation to combine *many* items into broader categories. Some participants may seek to achieve consensus by this means and the precision of the

Source: Adapted with permission of Sage Publications from *Group Techniques for Idea Building* by Carl M. Moore. © 1987.

THE NOMINAL GROUP PROCESS (continued)

original items may be lost, or the combined item will become so abstract and all-inclusive that the group in effect is able to avoid the difficult choices inherent in prioritizing.

Step 4: Voting.

Each participant selects five items that are most important to him or her, writes them down, and rank orders them (1 = *least* important; 5 = *most* important). Record the priority numbers on newsprint in front of the group. The numbers are then added, resulting in a total for each item. Items can then be prioritized – those items with the highest numbers are considered the highest priority. The group then discusses the voting patterns. If desired, the items can be further clarified and a second vote taken.

STRATEGIES FOR PRODUCTIVE, EFFICIENT TEAM MEETINGS

A good starting point for a team is to negotiate which of these they will use.

1. Start on time.

2. Encourage *Excitement Sharing*. Each meeting begins with a leader saying something like, "What is new and exciting in your lives since we last met?" Anyone who feels like it then briefly shares with the group any new and exciting experience, insight, feeling, etc. Some advantages of excitement sharing are: *it helps start meetings on time* since everyone does not have to be there to begin (since it is enjoyable, however, it encourages people to arrive on time); it helps participants get to know each other better. Caution: One danger is that excitement sharing could go on for hours; therefore, don't go beyond an agreed-upon limit, say ten minutes.

3. Review and develop the meeting *agenda*. Near the beginning of each session, the agenda should be reviewed so that it can be changed or expanded to accommodate new ideas and priorities. The agenda should be handed out or recorded on newsprint in view of the whole group.

4. *Set time limits* for the meeting and perhaps for individual agenda items. You may have to set some agenda priorities.

5. Take *Action Minutes*. It is easy for a group to forget "*who* was going to do *what* by *when*?" *Action Minutes* provide a very complete but streamlined material record (see page 15-31).

6. Conduct one piece of business at a time. It may help to appoint one member of the group as a *task minder*.

7. Route off-task insights or problems to an *Odds and Ends List* for later attention. Often in the course of a meeting, problems or issues are raised that can sidetrack the group from its agenda. When these problems or issues are significant but not relevant to the task at hand, they can be routed to an *Odds and Ends List* which is carried forward to future meetings on the *Action Minutes*.

Source: *Building Systems for Professional Growth: An Action Guide* by Margaret A. Arbuckle and Lynn B. Murray. Andover, MA: The Regional Laboratory for Educational Improvement of the Northeast and Islands. ©1989, 4-55 through 4-57.

STRATEGIES FOR PRODUCTIVE, EFFICIENT TEAM MEETINGS (continued)

8. Continually work on the *group's process.*

   Encourage participation by all, even the quietest members. (Participation is a right . . . and a responsibility.)

   Communicate authentically. What a person says should reflect what he or she thinks as well as feels.

   Conduct group business in front of the group; conduct personal business outside of the meeting.

   Develop conditions of respect, acceptance, trust, and caring.

9. Develop *alternative approaches* to the solutions of a problem. In problem solving of almost any type, you are far more likely to choose the best path if you generate as many alternatives as possible.

   To start, encourage *all* possible ideas. Rule out evaluation. *Quantity* of ideas counts here. Pool your wild ideas. Review and clarify the ideas. Look for clues to something found in even the wildest ideas. Let the people who gave the idea explain what they had in mind.

   Apply the group's critical judgment to determine the best possible solutions from the total list.

10. Test the group for *readiness to make decisions.* Quickly answer these questions:

    Is the person or group most affected by the decision represented?

    Does the group have enough high quality information to make a decision?

    Does the group have the authority to make the decision? (Is the person or group who will be responsible for carrying out the decision represented?)

STRATEGIES FOR PRODUCTIVE, EFFICIENT TEAM MEETINGS (continued)

11. Determine what *decision-making method* suits each decision. (Develop a quick routine to do this.)

Decision-Making Method	Decision-Making Process	Consequences
Majority decision	Vote, majority rules, the minority simply must accept decision.	May limit arguments or reduce the time required to reach agreement; tends to impede healthy discussion and may reduce constructive criticism.
Consensus decision	Altering substance of decision through debate and discussion until all members can accept it.	Provides for alternative thinking and an interchange of ideas; tends to dissipate authority but also may reduce individual autonomy; requires high degree of interpersonal understanding and acceptance; time-consuming.

12. Make the decision (remember, silence does not always mean agreement).
13. Assign follow-up actions and responsibilities on *Action Minutes*.
14. Summarize what has been accomplished.
15. Decide the date and place of the next meeting.

STRATEGIES FOR PRODUCTIVE, EFFICIENT TEAM MEETINGS (continued)

16. Develop a preliminary agenda for the next meeting. Refer to the *Odds and Ends List* for possible agenda items or direct those items elsewhere and record in *Action Minutes.*

17. Evaluate the meeting. (Look at the group's efficient, productive use of time and each group member's feelings about the team itself.)

    It is important to have an evaluation near the end of every meeting, not only to recognize the positive and exciting things you liked about the meeting so that you can repeat them next time, but even more importantly, to identify those things about the session which participants didn't like so that you can make creative changes for the next meeting.

    Consider using an *Inside or Outside Assessment Technique.* Group process inventories completed first by individual team members and then shared by the group allow the team to analyze the group's efficient, productive use of time, as well as group behavior, roles, and skills. At times it might be helpful to invite an outside observer to visit a meeting. She/He can use a group process inventory to record observations, share these observations at the end of the meeting, and facilitate a discussion on how the group is functioning.

18. *END ON TIME!!!!* Time is a precious commodity for team members. Respecting agreed-upon time limits builds team trust.

STRATEGIES FOR PRODUCTIVE, EFFICIENT TEAM MEETINGS (continued)

Team Members Present:	**Action Minutes** Page ___ of ___	Today's Date ______________ Recorder ______________ Date/time/place of next meeting ______________ ______________

Agenda Item	Staff Member Initiating	Summary of Discussion/ Task List	Action Decision	Staff to Follow Up	Target Date Completion

Possible Agenda Items for Next Meeting	Odds and Ends List

Source: *Building Systems for Professional Growth: An Action Guide* by Margaret A. Arbuckle and Lynn B. Murray. Andover, MA: The Regional Laboratory for Educational Improvement of the Northeast and Islands. ©1989, 4-59.

GUIDELINES FOR LEADERSHIP IN SMALL GROUPS

1. *Keep opening remarks brief.* It is necessary to see that all members are acquainted; however, the introduction of members and the topic for discussion should be kept brief. State the objectives of the session, outline what is to be accomplished, and indicate how it will benefit the participants.

2. *Check perceptions of group members.* Ask for participant views on expectations and understanding of objectives. (Are we all clear on this?)

3. *Suggest a structure for the group.* Propose an approach and time frame. Modify, using group input, and check for understanding (Is that okay with you?) before proceeding. Elements of structure may include following an outline or agenda, using a recorder and newsprint, round-robin participation, open discussion, appointing a summarizer or time-keeper, etc. All of these ideas serve to organize the group to accomplish the objective.

4. *Keep the group focused on the objectives.* It is normal to move off on tangents from the central question. Sometimes tangents are productive and yield good ideas. You may sense when the tangent is no longer productive and pull the group back. A question like "How does this relate to our objective?" or "We have strayed from the topic and need to return to the question of . . ." is a better intervention than not doing anything at all.

5. *Summarize frequently.* This can be done at intervals by the leader or by someone appointed to do it. Ten to fifteen minute intervals work well. "So far, we seem to have said. . . ."

6. *See that all members have an equal chance to participate.* Some people are reluctant to speak out. Others can't get a word in because of aggressive individuals who are present. Use open questions directed to the reluctant ones. Ask the others to give everyone a chance. When you direct a question to the group, let your eyes meet those who seem reluctant.

7. *Thoroughly discuss all aspects of the situation.* It may be tempting to move into a new agenda item after only one or two members have aired their views. Thorough discussion is especially important in problem-solving situations, where it is easy to move to problem analysis before the problem has been completely or adequately defined.

Source: Reprinted with permission of Douglas S. Fleming of the Northeast Regional Exchange from "Guidelines for Leadership in Small Groups." ©1985.

GUIDELINES FOR LEADERSHIP IN SMALL GROUPS (continued)

8. *Display interest and enthusiasm.* The leader needs to be aware of all of the interrelationships of ideas and information. Listening is as important for the leader as it is for group members. By maintaining eye contact with the speaker and demonstrating appropriate "attending" behaviors, you can prevent yourself from losing a grip on content while you think about process.

9. *Bring the discussion to a definite conclusion.* In too many meetings, members rush off without arriving at a consensus or even a majority decision. The conclusion may be a summary of progress, a scan of recorded information on newsprint, or an evaluation of the meeting. Give some finality to the event in any case. This contributes to a sense of accomplishment and purpose.

OBSERVER GUIDE

Things to look for:

Participation: Did all have opportunities to participate? Were some excluded? Was an effort made to draw people out? Did a few dominate?

Leadership: Did a leader, as such, emerge? Was a leader designated? Was leadership shared? Was there any structuring of the group?

Roles: Who initiated ideas? Were they supported and by whom? Did anyone block? Who helped push for decisions?

Decision Making: Did the group suggest lots of ideas before beginning to decide, or did it begin by deciding on only a single idea? Did everyone agree to the decisions made? Who helped influence decisions of others?

Communication: Did people feel free to talk? Was there any interrupting or cutting people off? Did people listen to others? Were there clarifications of points made?

Sensitivity: Were members sensitive to the needs and concerns of each other?

How well did the group work?

Poorly ⇐ 1 2 3 4 5 ⇒ Really Well

How could it work more effectively?

Source: *Building Systems for Professional Growth: An Action Guide* by Margaret A. Arbuckle and Lynn B. Murray. Andover, MA: The Regional Laboratory for Educational Improvement of the Northeast and Islands. ©1989, 4-65.

SOME CHARACTERISTIC BEHAVIORS FOUND IN PRODUCTIVE GROUPS

1. *Members listen intently.* They work at understanding what others are saying, ask others to repeat and clarify, paraphrase what they hear, and ask if they heard correctly.

   Who in this group is asking for clarification? ______________________

   Who is paraphrasing what others have said? ______________________

   Who is checking to see if he/she understands new ideas presented? ______________________

2. *Members make sure things are said clearly.* They elaborate, give illustrations, ask the listener to paraphrase what he/she has heard, repeat and restate statements to insure increased correct input reception, and ask for confirmation as to whether the others heard correctly.

   Who in this group is being particularly careful to be sure others in the group understand what is being said? ______________________

3. *Members contribute to an awareness of the group's process.* They call attention to what is happening in the group and invite others to give their opinions and perceptions of what is going on.

   Who in this group is calling attention to how the group is doing? ______________________

   Who is asking how other members feel about how the group is working together? ______________________

   Who points out how decisions are being made in the group? ______________________

Source: *Building Systems for Professional Growth: An Action Guide* by Margaret A. Arbuckle and Lynn B. Murray. Andover, MA: The Regional Laboratory for Educational Improvement of the Northeast and Islands. ©1989, 4-67 through 4-68.

SOME CHARACTERISTIC BEHAVIORS FOUND IN PRODUCTIVE GROUPS (continued)

4. *Members keep alert to ways in which they can support others in the group.* They take various roles and functions from time to time that assist other group member to work more effectively.

   Who asks helpful questions? ______________________________

   Who synthesizes/summarizes what has been said so far? ______________

   Who uses humor to help the group move along? ____________________

5. *Members help the group by using a diagnostic approach.* They use their ability to understand *why* things have happened and offer to the group their observations and suggestions.

   Who makes suggestions to help the group? ________________________

   Who helps the group see where they have gotten bogged down? __________

   Who encourages the group to check ideas for workability without discouraging new ideas? ______________________________

6. *Members operate as full members of the group.* They actively seek to learn and help others learn and work in the group.

   Who encourages quieter members of the group to participate? ___________

   Who brings the group back to the task at hand? ____________________

   Who organizes "who will do what, when" to follow up a meeting? __________

   ____

7. *Members contribute to productive goal setting and decision making.*

   Who helps the group get started/restarted by suggesting tasks or goals? ________

   ____

   Who asks for or adds information on ideas presented? _______________

   ____

   Who checks the whole group to see how much agreement has been reached?

   ____

A YARDSTICK FOR MEASURING THE GROWTH OF A TEAM

As a group begins its life, and at several points during its growth, the leader and members might reflect on the following group characteristics and spend some time sharing the data that are collected. Through rating each characteristic, it is possible to get a general picture of the perceptions that various members have about the team and how it is developing. It is also possible to identify difficulties that may be blocking progress:

A. Goal clarity

1	2	3	4	5
No apparent goals	Goal confusion	Average goal clarity	Goals mostly clear	Goals very clear

B. Trust and openness

1	2	3	4	5
None	Little	Average	Considerable	Remarkable

C. Empathy among members

1	2	3	4	5
None	Little	Average	Considerable	Remarkable

D. Balance between group task and maintenance needs

1	2	3	4	5
None	Little	Average	Considerable	Remarkable

E. Leadership needs

1	2	3	4	5
Leadership needs not met	Some leadership needs met	Average meeting of leadership needs	Good meeting of leadership needs	Excellent meeting of leadership needs

F. Decision making

1	2	3	4	5
Unable to make decisions	Inadequate decision making	Average decision making	Good decision making	Full consensus

G. Use of group resources (knowledges, skills, experiences)

1	2	3	4	5
Not used	Poorly used	Average use	Well used	Fully and effectively used

H. Sense of belonging

1	2	3	4	5
None	Some	Average	Good	Strong

Source: *Building Systems for Professional Growth: An Action Guide* by Margaret A. Arbuckle and Lynn B. Murray. Andover, MA: The Regional Laboratory for Educational Improvement of the Northeast and Islands. ©1989, 4-69.

HOW ARE OUR TEAM MEETINGS GOING?

A Checklist

Always	Sometimes	Never	
☐	☐	☐	1. We start our meeting on time.
☐	☐	☐	2. We begin our meeting with a "limited" period of **Excitement Sharing** (a time for members to catch up on new and exciting experiences, insights, etc.).
☐	☐	☐	3. We review and develop the meeting's agenda before beginning work.
☐	☐	☐	4. We set time limits for the meeting (and perhaps individual agenda items).
☐	☐	☐	5. We identify a recorder to take **Action Minutes** using a form developed for that purpose.
☐	☐	☐	6. We use an **Odds and Ends List** to avoid getting side tracked on important but "off-task" issues.
☐	☐	☐	7. We encourage participation by all, even our quietest members.
☐	☐	☐	8. We use **Brainstorming** to develop alternative approaches to the solutions of a problem.
☐	☐	☐	9. We test our group to see if we are ready before making a decision.

Source: *Building Systems for Professional Growth: An Action Guide* by Margaret A. Arbuckle and Lynn B. Murray. Andover, MA: The Regional Laboratory for Educational Improvement of the Northeast and Islands. ©1989, 4-81.

HOW ARE OUR TEAM MEETINGS GOING? (continued)

A Checklist

Always	Sometimes	Never	
☐	☐	☐	10. We use an established routine to identify which **Decision Making Method** we will use for a particular decision (majority vote, consensus, etc.)
☐	☐	☐	11. We finalize plans on "who will do what by when" on the **Action Minutes** before concluding our meetings.
☐	☐	☐	12. We summarize what has been accomplished in each meeting.
☐	☐	☐	13. We briefly evaluate each session in terms of the group's efficient, productive use of time, and each member's feelings about how the team is operating.
☐	☐	☐	14. We use "self-assessment" tools to assist our team in analyzing its effectiveness.
☐	☐	☐	15. We end our meetings on time.

16

Systems Thinking: A New Mental Model

Audience:

- Individuals responsible for designing and supporting change in science and mathematics at all levels.

Desired Outcomes for Participants:

- To describe some mental models for change in education.
- To use the mental models to analyze and formulate responses to a variety of problem situations.

Materials:

- **Transparencies:**
  - *Mental Models* (16-5)
  - *Does Systems Thinking Require a Shift in Your Mental Model of Education?* (16-6)
  - *Analyzing the Mental Models* (16-7)
- **Handouts:**
  - *Does Systems Thinking Require a Shift in Your Mental Model of Education?* (16-8)
  - *Scenarios* (16-9 and 16-10))
  - *Scenario Worksheet* (16-11)
- Overhead projector and screen
- Newsprint, easels, markers, tape, and pens or pencils

Time Required: Two hours

Facilitator's Notes: In his book, *The Fifth Discipline: The Art and Practice of the Learning Organization*, Peter Senge defines mental models as "deeply ingrained assumptions, generalizations, or even pictures or images that influence how we understand the world and how we take action" (1990, 8). As we examine his and others' ideas about systems thinking and systems change (see **Additional References** on page 16-4), our own mental models are likely to change. This activity encourages that rethinking process.

This activity is a logical extension of **Activity 1: Framing the Dialogue Around Systemic Change** and can easily come right afterward. It is important to provide participants with sufficient time and opportunity to explore the concepts of the mental models presented in this activity and allow them to begin to construct their own knowledge of how a systems thinking approach might be applied. Rather than present a "right" and "wrong" approach, allow participants to explore the nature of each model and consider its use in real-world contexts. Encourage participants to explore the strengths and weaknesses of each model. Whenever possible, ask for examples from their own experiences to support the discussion.

Process:

1. Ask participants to turn to a partner and share the completion of this sentence: "A mindset of mine is. . . ."

2. Explain that mindsets are very powerful. Tell the following story as an example:

   How many of you have ever been to the San Diego Zoo? (Ask for a show of hands.) *As you may know, the zoo sets up special environments for the animals there that match the animals' needs. This is a true story about a particular bear that arrived at the zoo. Unfortunately, the bear arrived before its environment was complete. The zoo manager decided to tranquilize the bear, cage him, and place him amidst the workers who were working around the clock to finish the bear's environment – the water, the shrubbery, the rocks, etc. Well, eventually, the bear began to wake up; it stood on its hind legs and noticed that it was in a cage. It went to the side of the cage, held onto the bars, and roared at the top of its lungs. It paced to the other side of the cage, grabbed onto the bars, and let out a tremendous roar. Back and forth, back and forth, the bear paced.*

   The workers saw the distress of the bear and notified the zoo manager and said, "Please, please do something about this bear; we're not finished, but the bear is very unhappy." So the zookeeper once again tranquilized the bear and, as the bear slept, the workers worked around the clock trying to finish before the bear would reawaken. Unfortunately, they were not finished when the bear woke up again. He looked around, he yawned and stretched. He stood up. He took three paces to the right, grabbed onto the bars, and let out an incredible roar of anger and frustration, and then he walked to the other side of the cage, and once again let out a roar. The workers were so distraught with the bear's frustration that the zoo manager had to tranquilize the bear once again. Again, the workers weren't finished *when the bear woke up, so the bear all but shook the cage into oblivion with frustration. Once again the bear was tranquilized.*

*Finally, the workers finished their work. They dismantled the cage around the sleeping bear and slipped off to the side to watch as the bear woke up. When he did, no sooner did he stretch and look around than he stood up, took three paces to the right, grabbed onto imaginary bars, and let out an incredible roar of anger – worse than ever. Then he walked to where the other side of where the cage had been, grabbed imaginary bars, and roared once again. Back and forth the bear went, roaring unhappily. Even though the bars of the cage were removed, the bear maintained the mindset that he was, in fact, still caged.**

3. After the story, have participants talk to their partner about times when they have felt like that caged bear. Show the **Mental Models (16-5)** transparency explaining that as we examine Senge's and others' ideas about systems thinking and systems change, our own mental models are likely to change.

4. Display the **Does Systems Thinking Require a Shift in Your Mental Model of Education? (16-6)** transparency and allow time for participants to consider the two columns. Distribute the more detailed handout **Does Systems Thinking Require a Shift in Your Mental Model of Education? (16-8)**. Ask two sets of partners to form groups of four and compare their own mental models with those presented.

5. After an initial report out of reactions to the two columns, show the **Analyzing the Mental Models (16-7)** transparency and ask participants to continue working in groups to answer the questions. Give as an example for Question 1, e.g., the traditional model might be described as believing there is a solution to all problems.

   Record participants' responses on newsprint and post around the room. You may need to use some prompts to initiate the discussion. (See Figure 1 in *Science Education for the 1990s: Strategies for Change*, included in **Activity 18: Expanding Our Understanding of Systemic Change** as a reading, for ideas.)

6. Ask participants to reflect on a recent situation in which they may have encountered either model and invite several to share their stories. Use these stories to explore the concepts inherent in each model.

---

*The idea for this story came from Bob Garmston, Facilitation Associates, El Dorado Hills, CA.

Ask participants to go back into their small groups. Distribute the handouts **Scenarios (16-9 and 16-10)** and **Scenario Worksheet (16-11)** and assign each group a scenario; ask them to design an approach to solving the problem presented in the scenarios using *each* of the models. Encourage participants to evaluate the strengths and weaknesses of each model for the particular scenario.

7. Ask each small group to share the results of their discussion back in the large group setting. Allow time for questions, comments, and responses. Encourage participants to openly express their thinking and stress the idea that there is no right and wrong answer in this process. The purpose is to foster different visions than those that have guided practice for years.

8. Ask participants to reflect on how their thinking about the two models evolved through the process. What have they learned in this activity? How can they use what they have learned? Refer participants to the articles listed under **Additional References** below.

Additional References:

Fullan, Michael. 1993. "Innovation, Reform, and Restructuring Strategies," In Gordon Cawelti, ed., *Challenges and Achievements of American Education*, The 1993 Yearbook of the Association for Supervision and Curriculum Development. Alexandria, VA: Association for Supervision and Curriculum Development, 116-133.

Senge, Peter. 1990. *The Fifth Discipline: The Art and Practice of the Learning Organization*. New York: Doubleday, Inc.

Senge, Peter and Colleen Lannon-Kim. November 1991. "Recapturing the Spirit of Learning Through a Systems Approach," *The School Administrator* 48 (9): 8-13.

Senge, Peter; Charlotte Roberts; Richard B. Ross; Bryan J. Smith; and Art Kleiner. 1994. *The Fifth Discipline Fieldbook*. New York: Currency Doubleday.

Smith, Marshall S. and Jennifer O'Day. April 1991. "Putting the Pieces Together: Systemic School Reform" in *CPRE Policy Briefs*. New Brunswick, NJ: Consortium for Policy Research in Education (CPRE).

St. John, Mark. 1992. "Science Education for the 1990s: Strategies for Change." Inverness, CA: Inverness Research Association, 37-51.

Note: Some of these references are included as readings in Activity 18.

MENTAL MODELS

"Mental models . . . are deeply ingrained assumptions, generalizations, or . . . images that influence how we understand the world and how we take action."

— Peter Senge, 1990

Source: Senge, Peter. 1990. The Fifth Discipline: The Art and Practice of the Learning Organization. New York: Doubleday, Inc.

DOES SYSTEMS THINKING REQUIRE A SHIFT IN YOUR MENTAL MODEL OF EDUCATION?

TRADITIONAL MODEL	SYSTEMS THINKING MODEL
Top-down command and control	Shared decision making
Organizational knowledge bottled up, fragmented among "experts"	Knowledge flows throughout the system
Low priority on innovation and questioning	High priority on innovation and questioning
Teachers as deliverers of learning	Teachers as facilitators of knowledge

Source: Adapted with permission of the Education Commission of the States from "Restructuring the Education System." ©1992, 1-6.

ANALYZING THE MENTAL MODELS

- What are the qualities or characteristics or concepts that define each model based on the examples provided?

- What additional characteristics fit into each model?

- Can you add pairs of statements to the chart to further exemplify the nature of the model?

DOES SYSTEMS THINKING REQUIRE A SHIFT IN YOUR MENTAL MODEL OF EDUCATION?

	Traditional Model	Systems Thinking Model
Community Responsiveness	Closed to community around it; unable to be responsive	Open to community around it; able to learn, change with the times
Planning	Highly centralized planning	Planning distributed widely through all levels of the system
Decision Making	Top-down command and control	Shared decision making
Knowledge Flow	Organizational knowledge bottled up, fragmented among "experts"	Knowledge flows throughout the system
Innovation	Low priority on innovation and questioning	High priority on innovation and questioning
Teachers' Role	Teachers viewed as deliverers of knowledge	Teachers viewed as facilitators of learning
Values	Little conversation about values, purposes, and norms; little chance of changing them	Constant exploration of values, purposes, norms, and capacity to change them
Management Style	Managers see job as telling others what to do, assessing performance	Managers see job as raising questions, facilitating discussion, listening
Resource Use	Human and material resources spent largely on disputes, reinvention, quick fixes, circumvention, interest-group deadlock	Human and material resources devoted to sharing, invention, creative and critical thinking, accountability, reflection, learning – among both adults and students

Source: Adapted with permission of the Education Commission of the States from "Restructuring the Education System." ©1992, 1-6.

SCENARIOS

Instructions: Design an approach to solving the problem presented in the scenario using *each* of the models. Evaluate the strengths and weaknesses of each model for the particular scenario.

1. A new mathematics teacher is having problems with students not bringing supplies to class. A growing number of students forget to bring their homework, paper, pencils, and textbook. The teacher has allowed students to return to their lockers after the bell to collect the needed items, but now has realized the situation is out of hand.

   Alternative Tasks: Design an approach to this situation either as the teacher attempting student management or as the principal attempting teacher management.

2. Next year's budget cuts have resulted in a 50 percent reduction in the supply budget. The science department at your middle school must address the situation before leaving school for the summer. The teachers in the department are convinced that labs must be done on a regular basis. As one teacher puts it, "The only way I can motivate my kids is with the promise of doing a lab every two weeks."

   Alternative Tasks: Design an approach to this situation either as the principal or as the department head.

3. The state legislature has recently passed a bill that will require the state department of education to incorporate performance-based assessments in the state testing program within five years.

   Task: Design an approach to this situation as the curriculum coordinator in your school system who is working with a staff that generally tests students with the objective support materials accompanying the state-adopted texts.

4. The district superintendent is concerned about the underrepresentation of minorities and females in advanced science and mathematics courses in the district high schools. She has asked all principals within the district to develop a plan to address this problem.

   Task: Design an approach to this situation as a middle school principal whose graduating minorities and females rarely enroll in advanced science and mathematics courses in high school.

SCENARIOS (continued)

5. A recent survey in your district revealed that elementary teachers feel they are poorly prepared to teach science. This attitude is further demonstrated by the survey report that the majority of the elementary teachers only teach science three times a week (the state minimum requirement).

   Task: Design an approach to this situation as an elementary school principal whose school consistently produces the lowest science scores in your school system.

6. Write your own. Use one of your personal experiences to develop an original scenario to address by designing an approach to take in your actual role.

SCENARIO WORKSHEET

Scenario Number ____

Task	Traditional Approach	Systems Thinking Approach
Solution		
Strengths		
Weaknesses		

17 A CONTINUUM OF SYSTEMIC CHANGE

Audience:

- Individuals responsible for designing and supporting change in science and mathematics at all levels.

Desired Outcomes for Participants:

- To understand "systems thinking" as it relates to education.
- To identify elements of the educational system and how they will need to change in the future.
- To assess where they are on a continuum of systemic change.
- (*Optional*) To develop an action plan to facilitate desired changes.

Materials:

- **Transparencies:**
  - *Terms from Systems Science* (17-6)
  - *Concept Mapping of a System* (17-7)
- **Handouts:**
  - *Does Systems Thinking Require a Shift in Your Mental Model of Education*? (16-8)
  - *Paradigm Shift Worksheet* (17-8)
  - *The Shifting Paradigm* (17-9 through 17-20)
  - *Continuum Worksheet* (17-21)
  - *Action Plan Worksheet* (17-22)
  - *Action Plan Progress Report* (17-23)
- **Reading:** (*Optional*)
  - "How Can Horace Best Be Helped?" by Bill Honig. *Phi Delta Kappan*, June 1994, 75 (10): 790-796.
- Overhead projector and screen
- Newsprint, easels, markers, tape, blank paper, and pens or pencils

Time Required: Three to four hours

Facilitator's Notes: The purpose of this activity is to move beyond **Activity 16: Systems Thinking: A New Mental Model** and to provide participants with an opportunity to apply systems thinking to their view of the educational system. Depending on the audience, the activity may focus on any level of the educational system from the state education agency to an individual classroom. Through systems science, a body of knowledge has been developed that describes the organization and operation of systems. These concepts form the basis for applying systems thinking to education. This activity is designed to help participants use systems thinking concepts in the context of their own organizations.

Participants who are new to systems thinking might need help to envision what it would look like in action. To provide a concrete example, you might use the Honig article, which highlights California's efforts to "scale up" school reform in a systemic way.

Process:

1. Use the **Terms from Systems Science (17-6)** transparency to introduce the basic concepts of systems. In systems science, an element of a system is a necessary but not self-sufficient component of a system. That is, the system cannot achieve its purpose without the element, and the element by itself cannot replicate the system's functions (Betts 1992).

2. Ask participants to work in small groups of four or five and reflect on how these concepts of systems relate to the educational system. Ask them to brainstorm the elements of the educational system as they see it. You might suggest participants select one specific level – the classroom, building, district, or state, or consider a holistic view of the "educational system."

   Have each group record and post the results of their brainstorming session on newsprint so all can see. Some possible elements might be: students, community, parents, business, administration, assessment, curriculum, teaching strategies, scheduling, teacher preparation, professional development, facilities, materials, etc.

3. Use the **Concept Mapping of a System (17-7)** transparency to introduce the notion of concept mapping. If you think concept mapping will be a new idea for participants, make a copy of the transparency for each group to refer to. Distribute newsprint and a marker to each group. Charge the groups with the task of developing a concept map of the educational system as they see it using the list of system elements generated earlier and posted on newsprint by the small groups. Encourage them to use elements from other groups. Allow approximately 20 minutes.

4. Have each group share their work with the whole group. Encourage participants to look for similarities and differences among the illustrations presented.

5. Again, divide participants into small groups. It might be useful to change the membership of the groups this time to stimulate new discussions and introduce varying perspectives into the small group organization. Ask each group to select one or two of the elements identified in the discussion of the educational system. Using the idea of shifting from the current paradigm to an emerging paradigm introduced in **Activity 16: Systems Thinking: A New Mental Model**, have each group identify and list the characteristics that describe the element they have chosen under the current and emerging paradigms. Suggest they refer back to the handout **Does Systems Thinking Require a Shift in Your Mental Model of Education? (16-8)** as they do so. Statements under the "From" column should describe the present situation that exists for the selected element while the items under the "To" column should describe the emerging paradigm.

   Encourage participants to consider the emerging paradigm as their "wish list" – what their vision of the future might reflect. To get the group started it might be helpful to construct an example on newsprint. For example, using the element "teaching strategies," the paradigm shift might look like this:

   Teaching Strategies

From	**To**
teacher-centered	student-centered
lecturer	resource person
textbook-driven	resource-driven
individual subjects	integrated approach

   Provide each group with newsprint and a marker. The handout **Paradigm Shift Worksheet (17-8)** is provided as an alternative to newsprint or a tool to document results of the activity.

   Allow approximately 20 to 30 minutes for small group work. Upon completion, ask the small groups to present their paradigm shifts to the larger group. Allow time for participants to dialogue on the content of the presentations. Post the newsprint with "From-To" results for everyone to see. Encourage the large group to suggest additions to the various paradigm shifts presented by the small groups.

Distribute the handout **The Shifting Paradigm (17-9 through 17-20)** and allow time to compare the work of the group with the perceptions of the author. Encourage discussion.

6. Distribute the handout **Continuum Worksheet (17-21)** to each participant. Ask individuals to select one of the elements of particular interest to them and several "From-To" descriptors for the element. Have them construct a continuum by placing the statement in the appropriate column of the work sheet at opposite ends of a continuum scale. You may want to demonstrate with an example on newsprint. Encourage them to select only those "From-To" descriptors that are meaningful to them. After filling in the end points on their **Continuum Worksheet** using the identified descriptors, individuals place an "X" on the continuum to represent the location of them as individuals or of their school, district, or state at this time. They may add other descriptors as well.

7. Ask participants to consider the continuum and reflect in writing on the questions below. Upon completion, encourage either small or large group discussion of reactions to the questions:

   - Is movement across the continuum desirable? Why or why not?
   - If movement is desirable, what can you do to facilitate that movement?
   - How will moving across the continuum mean doing things differently?
   - How can what you do be systemic?
   - What resources do you need to facilitate that movement?

8. (*Optional*) Distribute the handout **Action Plan Worksheet (17-22)**. Allow participants time to identify actions that they can take to facilitate desired changes identified in the previous exercise. Encourage individuals from the same school or organization to develop their action plan collaboratively. Allow ample time to work.

   If time allows, have individuals or groups share their ideas with the large group. Distribute the handout **Action Plan Progress Report (17-23)** and encourage participants to pause, reflect on their progress, and complete one of these on a regular basis as their plan progresses.

(Optional) If participants are new to systems thinking, have them read the Honig article (listed under **Reading**). This will suggest some action steps through an example of how one state (California) addressed issues of buy-in, curriculum, implementation, and vision building.

9. Look back at the seven guidelines from the "Leading Through Systems Thinking" article from **Activity 1: Framing the Dialogue Around Systemic Change**. How has your understanding of the guidelines been expanded by this activity? Examine how the guidelines are reflected in your group's **Paradigm Shift Worksheet**, **Continuum Worksheet**, and **Action Plan Worksheet**.

Additional References:

Betts, Frank. November 1992. "How Systems Thinking Applies to Education." *Educational Leadership* 50 (3): 38-41.

Spector, Barbara S. 1993. "Order Out of Chaos: Restructuring Schooling to Reflect Society's Paradigm." *School Science and Mathematics* 93 (1): 9-19.

TERMS FROM SYSTEMS SCIENCE

Element of a System

A necessary but not self-sufficient component of a system such that the system cannot achieve its purpose without the element, and the element by itself cannot replicate the system's function.

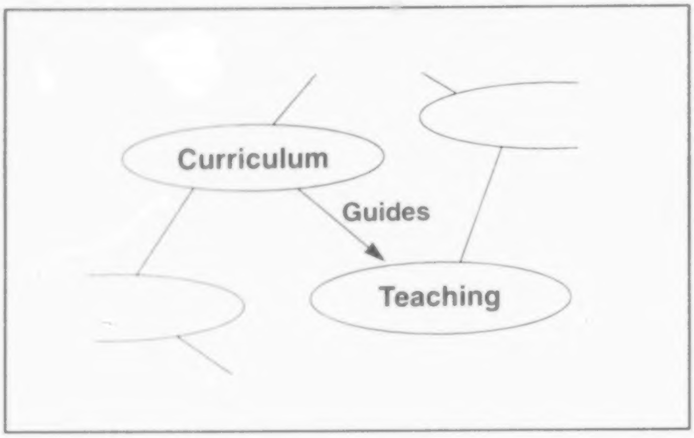
— Betts 1992

Relationship

How any two elements of a system are related to one another.

Source: Betts, Frank. November 1992. "How Systems Thinking Applies to Education." *Educational Leadership* 50 (3): 38-41.

CONCEPT MAPPING OF A SYSTEM



Characteristics

Elements of the system are represented by circles, squares, icons, or other symbols.

Elements can be inside other elements.

Relationships are represented using lines and/or arrows.

Relationships are defined using words that describe how one element relates to the other.

Relationships can be one way or two ways.

PARADIGM SHIFT WORKSHEET

System Element: ______________________________

Reforming science and mathematics education to address the National Education Goals would require a change in this element of the system *from* what *to* what?

FROM	TO

THE SHIFTING PARADIGM

Dominant Paradigm	New Paradigm
1. Intended outcome of schooling	**1. Intended outcome of schooling**
- performance on standardized test	- learn how to learn
- memorize accrued body of facts	- construct understanding and meaning
- apply algorithms to get correct answers to problems	- use constructed meaning to solve real life problems - think holistically to solve problems (make connections including among disciplines, develop metaphors)
- academic achievement (prepare for the next grade level in academic hierarchy)	- both academic and psycho-social achievement (interpersonal skills fostering relationships – membership in community, self-esteem, communicating to solve problems) - prepare to deal with current and future real world issues - understand self and others
2. School culture	**2. School culture**
- based on win/lose mind set (assumés for one person to gain something another must lose something)	- based on win/win mind set (assumes everyone in a situation can gain something – no one has to lose for another to gain)
- rational-technological perspective dominates	- effect overrides the rational-technological perspective
- efficiency is the primary value upon which decisions are made	- quality of life is the primary value upon which decisions are made
- stoic attitude obvious (consideration of personal concerns is not visible)	- caring attitude obvious (teacher/learner relationships incorporate personal concerns and develop through visible responses to each other)
- appears indifferent to individual's self esteem	- overtly protects individual's self esteem - perceived to be risk free

Source: Adapted with permission of the School Science and Mathematics Association from "Order Out of Chaos: Restructuring Schooling to Reflect Society's Paradigm" by Barbara S. Spector. ©1993, 9-19.

THE SHIFTING PARADIGM (continued)

Dominant Paradigm *(continued)*	**New Paradigm** *(continued)*
- values autonomy, isolation, and competition	- values connections, teaming, and collaboration (a professional learning culture) - values teacher/teacher, teacher/student interaction - values inquiry and reflection - requires thinking about thought (metacognition)
- values conformity (uniformity)	- values creativity and individualism: celebrates diversity
- assigns negative value to questions interpreting them as signs of ignorance	- values questioning as the vehicle for inquiry and construction of knowledge: rewards questioning
- considers answers to be ends in themselves	- considers answers to be the basis for new questions
- discourages parent/school interaction and involvement	- intensifies communication between home and school: parents (or surrogates) are viewed as a vital part of the culture of the schools
3. Teachers' entry into practice	**3. Teachers' entry into practice**
- state legislatures and state education agencies determine criteria for entry	- teachers determine criteria for entry through professional associations
- school boards determine standards for professional conduct and administrators monitor conduct	- teachers both determine standards for professional conduct and monitor conduct
4. Improvement of teachers' practice	**4. Improvement of teachers' practice**
- comes from more and better (exact) rules monitored more carefully	- comes from supporting development and integration of knowledge
5. Administrators' role	**5. Administrators' role**
- translate policies from the top into efficient rules and procedures	- encourage teachers to be decision makers by creating an environment and a system supportive to teacher decision making
- transmit information on a need-to-know basis: military model of information transfer	- pass along all available information

THE SHIFTING PARADIGM (continued)

Dominant Paradigm *(continued)*	**New Paradigm** *(continued)*
- base decisions on the management of large groups of students first	- base decisions on the well-being of students and teachers as individuals first
- move decisions top down through hierarchy	- move decisions horizontally among coalitions of administrators, supervisors, teachers, and other interested parties - develop parity and equal responsibility among university, school, and business/industry
- identify changes needed	- facilitate teachers identifying changes needed
- keep teachers individuated	- facilitate teachers becoming a community of connected colearners - bring people together in combinations with most potential to solve problems
- expect all teachers to perform equally in all areas of responsibility	- develop human potential capitalizing on the strengths of varied faculty
- audit teachers' practice and program	- facilitate teachers auditing practice and program
- measure excellence in teaching using criteria provided by external authority	- measure excellence using responsiveness to needs of client, feedback from clients, and respect from peers and community as criteria
- make explicit checklists to monitor teachers' behaviors: count number of times a teacher exhibits a behavior	- assess teachers' behaviors holistically and in context
6. Supervisors' role	**6. Supervisors' role**
- transmit knowledge developed and selected by someone above the teachers in the hierarchy	- enable teachers to share their craft knowledge
- transmit regulations in the form of curricula as scope and sequence, syllabus, and/or list of objectives	- make available current research, curricula, etc. to help teachers develop options to solve problems
- arrange for teacher training to implement mandated curricula and procedures	- facilitate teachers' professional growth and teachers' restructuring of school
7. Teacher's role	**7. Teacher's role**
- hired hand	- professional

THE SHIFTING PARADIGM (continued)

Dominant Paradigm *(continued)*	**New Paradigm** *(continued)*
- mechanic	- decision maker
- posture of victim (impotent)	- posture of potency
- accept and implement policies and regulations made by those above teachers in hierarchy	- collaborate with each other and other interested parties to make policies and regulations and implement them
- implement single best practice for teaching determined by those above teachers in hierarchy	- make judgments based on current scientific and pedagogic knowledge and specifics of each situation - conduct research on own and students' experiences as reflective practitioners - conduct peer review of programs and practice (collaborative site-based management) - identify changes needed in schools, select curricula, materials, and instructional approaches
- responsible for covering the material	- responsible for meeting needs of individual students
- responsible for cultivating one form of intelligence	- responsible for cultivating the capacities of students' multiple intelligences: empowering students to think with all their senses
- responsible for bringing all students to the same level of accomplishment	- responsible for enabling each learner to reach his/her own potential dictated by inheritance, culture, accomplishments, and experiences
- develop relationship with students as a group	- develop relationships with individual learners
- focus on content of discipline	- focus on student learning and subsequent growth
- fountain of knowledge posture	- colearner posture - model life-long learning
- information-giver who transmits the accrued body of knowledge didactically	- facilitate experiences from which students construct their own knowledge
- create teacher-centered classrooms	- create student-centered classrooms
- present disconnected facts in linear fashion	- reflect on the interconnectedness of information within the discipline and among disciplines to develop umbrella concepts and theories
- require adherence to one objective reality	- accept a broad range of realities

THE SHIFTING PARADIGM (continued)

Dominant Paradigm *(continued)*	**New Paradigm** *(continued)*
- individuated	- work in teams: transdisciplinary or with people in one discipline
- oriented to individual classroom	- oriented to the system
- conscious of pressure on self	- conscious and sensitive to pressure on individuals at all levels of the system: holistic view of impact of teachers' behavior on entire system
- isolated from community in professional practice	- work with community to facilitate real world experiences for students - understand self and others in role set
8. **Students' role**	8. **Students' role**
- be processed as if on an assembly line	- rearrange, add to, or delete information from personal conceptual framework
- memorize segregated factual information	- develop multidirectional linkages among segregated facts; construct knowledge inductively
- reproduce information on demand	- use constructed knowledge to solve problems
- produce the one correct answer	- generate more than one acceptable answer to a problem
- use one correct way to solve a specific problem	- generate optional ways to solve a specific problem
- copy the right (correct) sentence from a book to answer a question	- construct answer to a question by thinking and giving own perspective to answer the question
- assume "I can make it up by reading the book" after missing a class	- assume "I've missed something in the interaction and cannot make it up" after missing a class
- project responsibility for learning onto the teacher	- intellectually empowered as reflective learner to take responsibility for own learning - develop knowledge and understanding of self; student self-realization

THE SHIFTING PARADIGM (continued)

Dominant Paradigm *(continued)*	**New Paradigm** *(continued)*
9. Student body	**9. Student body**
- live in intact traditional families: one parent as homemaker and one as breadwinner	- live in innovative families (average two people); latchkey children are the norm
- majority are middle income	- majority are poor
- more homogeneous than different	- heterogeneous: a multitude of diverse cultures, ethnic groups, races, and languages
10. Curriculum	**10. Curriculum**
- builds on a positivist approach to knowledge	- builds on constructivist approach to learning
- adds individual facts annually as research produces new information	- significantly reduces breadth of content information
- content loaded with minutia and unrelated pieces of information fragmented into superficial categories	- focuses on processes to develop connections forming conceptual frameworks into which new information may be integrated: emphasizes holistic concepts (theoretical and perceptual)
- discipline boundaries are sacred	- is transdisciplinary: blurs discipline boundaries
- organized around structure of the discipline	- organized around themes, current real world issues, or history of discipline
- uses contrived problems in textbooks	- uses current real world problems
- topics reflecting current societal needs are add-ons or infusions	- emphasizes scientific approach to life, dealing in the realm of present possibilities and issues of societal significance
- portrays science as abstract rules made by people in the past and truths to be learned	- portrays science as a dynamic, unfolding discipline challenging the old truths: science as doing
- portrays science processes as depersonalized and mechanical	- portrays science processes as human and responsive to human perceptions and judgments
- divides science into traditional disciplines (e.g., biology, chemistry, physics, earth science)	- represents science as it is: about 40,000 fields and research interfacing other disciplines

THE SHIFTING PARADIGM (continued)

Dominant Paradigm *(continued)*	**New Paradigm** *(continued)*
- portrays scientist as a Caucasian man in a white coat working alone in a laboratory	- portrays scientist as a man or woman connected to a community of scientists
11. **Instruction (implementing curricula)**	11. **Instruction (implementing curricula)**
- directed by teachers' assumptions and the organization of the curriculum	- guided by students' questions and their perceived need to know: generative model
- assumes students are standardized	- assumes students have different learning styles and different stages of cognitive and psychological development
- assumes students come to class as blank slates: *tabula rasa*	- assumes students have prior knowledge from their own lives and from the collective biological capacities of the species
- reflects the values of predominantly white male middle class	- integrates the values of multiple cultures, classes, races, and both sexes
- mirrors the verbal analytical style of hierarchical thinking	- incorporates multisensate ways of knowing and bridges to verbal analytical reporting
- reflects training in a foreign language with focus on drill and practice	- reflects the way good science is practiced with focus on inquiry and communication (the nature of scientific thinking)
- focuses on rhetoric-of-conclusions	- focuses on using lines of reason to build theories - provides opportunity to formulate, test, and apply theories
- responds to questions with closed-ended answers	- responds to questions with questions developing lines of questioning (patterns of reasoning)
- activities are closed-ended	- activities are open-ended
- supports passive learning	- supports active learning
- emphasizes deductive reasoning	- emphasizes inductive reasoning
- textbook and worksheet based	- hands-on/minds-on experience based
- 3Ts dominate: Teacher, Talk, and Textbook	- varied modes are used including mapping: V, concept, and theory
- minimal experiences in the science laboratory using confirmation activities only	- on-going experiences in science laboratories doing investigations
- individuated learning strategies dominate	- cooperative learning strategies dominate
- fosters competitive environment	- fosters collaborative environment

THE SHIFTING PARADIGM (continued)

Dominant Paradigm *(continued)*	New Paradigm *(continued)*
- uses standard hard technologies in limited ways and to a minimal extent	- maximizes capacities of cutting edge hard technologies consistently - reflects awareness that the structure essential to facilitate teaching, learning, retention, and problem solving resides in the discipline itself - decisions lead to congruence among course goals, curriculum, instructional strategies, evaluation procedures, and students' behaviors
12. Evaluation	**12. Evaluation**
- false starts and missteps are indicators of poor laboratory work	- false starts and missteps are part of science and may be indicators of good laboratory work
- uses same approach to assess programs, monitor for policy, evaluate teachers' and students' performances, and convey expectations	- separate approaches to program assessment, monitoring for policy, teacher evaluations, student evaluation, and conveying expectations
- tests are designed externally, therefore do not correspond to curriculum	- tests are designed internally by teacher to reflect what is taught
- externally mandated and developed assessment; meets needs of policy makers	- curriculum specific assessment serves to improve instruction
- assesses discrete bits of knowledge	- assesses what society values
- reinforces science as a static body of disjointed pieces of information	- reinforces science as dynamic inquiry
- individual testing dominates	- cooperative testing dominates
- used by teachers to assign (and defend) a grade	- used in service of instruction
- separated from instruction	- embedded in instruction: lines blur between assessment and instruction
- fosters convergent instruction	- fosters divergent instruction
- multiple choice format dominates - assesses student achievement by one method: adding test scores	- assesses student progress by multiple methods (portfolio, design and conduct experiments, projects, inventions, essays, debates, concept maps, tests, etc.)
- monitors that students are on task: focus is on management	- monitors for students' understanding: focus is on learning

THE SHIFTING PARADIGM (continued)

Dominant Paradigm *(continued)*	**New Paradigm** *(continued)*
- assessment is conducted by the teacher	- self-assessment of learning progress is done by students
13. Research	**13. Research**
- applies objectivist approach to deriving new knowledge	- applies constructivist approach to generating new knowledge
- assumes the researcher is outside what is being studied: externalist perspective – objective	- assumes researcher is part of the reality being studied: internalistic perspective – subjective
- ignores respondents' realities	- integrates respondents' realities: takes phenomenalogical stance
- quantitative traditions dominate	- interpretive qualitative traditions dominate
- employs a priori (preordinate) designs	- employs emergent designs primarily
- accepts one method to produce viable truth	- acknowledges insufficiency of one method: cultivates multiple methods to create a holographic view of the whole
- hypothesizes and tests theories – assumes variables are known	- explores for meaning, identifies variables, generates hypotheses, formulates theories, and tests emergent hypotheses and theories
- brings deductive reasoning to bear primarily (focuses on analysis)	- brings inductive reasoning to bear primarily (focuses on synthesis)
- studies small pieces out of context	- studies pieces as parts of a whole in context (ecological perspective)
- controls behavior of research subjects	- allows normal flow of behavior for research subjects
14. Teacher inservice	**14. Teacher inservice**
Uses a staff development model which is characterized by features below:	Uses professional development (growth) model which is characterized by features below:
- mandated by someone in a supervisory role	- chosen by individual
- assumes learning is an outside-in process	- assumes learning is an inside-out process
- assumes changes in discrete behaviors improve teachers' decision making	- assumes teachers perceive, translate, and construct knowledge which improves teachers' decision making
- assumes growth and development are only a function of pedagogical practice	

THE SHIFTING PARADIGM (continued)

Dominant Paradigm *(continued)*	**New Paradigm** *(continued)*
- planned to assure exact implementation of prescribed processes	- planned to facilitate teachers generating optional processes through use of craft knowledge, mediated by research findings to solve the problems
- responsive to school district requirements, e.g., adopt a curriculum, or district management program, or federal or state law	- responsive to teachers' needs as they arise
- short duration (i.e., a few hours)	- continuous: life-long learning
- time and form are limited (usually meetings before or after school or occasional inservice days)	- takes unlimited forms (e.g., individual readings, inquiry, interaction with other professionals, formal courses, etc.)
- rewards are external	- rewards are internal and external
- focuses on making something look different	- focuses on improving student learning
- focuses on correcting specific teacher behaviors (remediation) and what is popular	- focuses on teacher growth as whole
- teachers in wait-to-be-told stance	- teachers in self-initiated stance
- teachers in passive role	- teachers in active role
- delivered primarily by university faculty	- delivered by university faculty, master teachers, informal education agencies (e.g., museums, aquaria), business and industry, and community leaders
15. Teacher educators' role	**15. Teacher educators' role**
(All features earlier hold true for teacher education also)	(All features earlier hold true for teacher education also)
- employ pedagogical approach	- employ androgogical approach
- know and transmit best practice	- collaborate with teachers as equals to determine options for practice
- isolated from teachers and other school personnel except when they are students in post-baccalaureate education situations or when teacher educator is observing student teachers in schools	- integrally involved with practitioners in schools; integrated into school, attending to varied aspects of schooling
- housed exclusively on university campuses	- housed full or part time in schools

THE SHIFTING PARADIGM (continued)

Dominant Paradigm *(continued)*	**New Paradigm** *(continued)*
- conduct research individually, frequently isolated from schools	- conduct research in schools collaboratively with teams of teachers
- work in colleges of education, frequently separate from faculty in other colleges	- work in integrated teams with faculty in other colleges
- individuated working within own college focusing on teaching methods courses	- serve as change facilitators designing and implementing strategies for improvement in university and K-12 school science and teacher education - serve as linking agents and interpreters among national, state, and local education agencies, higher education, professional associations, and business/industry - advocate for K-12 school improvement - advocate for professionalization of teaching
- teach discipline-specific methods separate from teaching discipline content	- teach discipline-specific methods integrated into discipline content by modeling, reflection, and analysis while teaching discipline being studied
- "do as I say, not as I do" is common teaching strategy	- all faculty model teaching behaviors congruent with the way people learn the discipline being studied
- add to teachers' collection of segregated facts	- enable teachers to reflect on acquired collection of facts to create multiple linkages among concepts and develop and select umbrella concepts
16. Textbook publishers	**16. Textbook publishers**
- publish books intended to cover all aspects of a discipline	- publish innovative selected topic books tailored for local audiences
- print books on large scale	- print short runs of books and stock modules on selected topics
- keep a book on market about 12 years with three revisions	- keep a book on market for fewer years with one revision - integrate computer and other technologies into textbooks

THE SHIFTING PARADIGM (continued)

Dominant Paradigm *(continued)*	**New Paradigm** *(continued)*
17. **Standards**	17. **Standards**
- are fixed in place	- change continuously in response to rapid changes in the world
- determined by people at the top of the hierarchy	- determined collaboratively by all those with interests in education

CONTINUUM WORKSHEET

Name: ______________________________

System Element: ______________________________

FROM	Scale	TO
	├────┼────┼────┼────┤	
	├────┼────┼────┼────┤	
	├────┼────┼────┼────┤	
	├────┼────┼────┼────┤	
	├────┼────┼────┼────┤	
	├────┼────┼────┼────┤	
	├────┼────┼────┼────┤	
	├────┼────┼────┼────┤	
	├────┼────┼────┼────┤	
	├────┼────┼────┼────┤	

ACTION PLAN WORKSHEET

Name: ______________________________

What changes would you like to facilitate?

From:

To:

What actions will you take?

How will you know if your actions resulted in the desired change?

Next Steps: Immediate

Long term

ACTION PLAN PROGRESS REPORT

Name: ____________________

Date: ____________________

What action(s) did you take?

What were the outcomes of this action?

How successful were you at making the desired changes?

If you had to do it again, what would you do differently?

Reprinted with permission of Phi
Delta Kappa from Phi Delta Kappan
by Bill Honig. (c) 1994, 790-796.

How Can Horace Best Be Helped?

California is figuring out ways to "scale up" school reform – that is, to expand the number of schools that are committed to a new vision of teaching and learning. Mr. Honig describes the strategies that the state has developed to encourage and support schools in their reform efforts.

BY BILL HONIG

BRYANT IS a small elementary school situated in the heart of the Mission District in San Francisco. Its diverse students come from some of the poorest neighborhoods in the city, and many don't speak English. The revised assessment used in California, CLAS (California Learning Assessment System), tests sophisticated thinking and problem-solving skills. In 1993 Bryant's fourth grade posted the best reading scores in the state, tied by only a handful of schools situated in the highest-income areas of California.

What accounts for this seemingly miraculous performance? The anomaly of a fantastic teacher? Certainly La Verne Apodaca, the teacher in question, is among the best teachers in the world. When you visit her class (now in fifth grade – and since second grade with the same teacher), you see all the theories about ideal

BILL HONIG is Distinguished Visiting Professor of Education at San Francisco State University.

Illustration by Mario Noche

BEST COPY AVAILABLE

learning and teaching take shape before your eyes. Students read demanding material and complete sophisticated projects both in school and at home. Their written work is extremely professional, and high-level discussions occur with regularity. Apodaca religiously attends professional development workshops and has successfully translated the emerging ideas of an active, thinking, engaging curriculum into the reality of her inner-city classroom.

But it wasn't only the teacher who made a difference. Seven years ago the test scores of Bryant students placed them at the bottom of the barrel. The transformation of the school was the result of the hard work of a dynamic principal, Barbara Karvelas, and a cohesive, dedicated staff whose members – many hired during the past seven years – have examined every area that could help improve the quality of learning at the school. Teachers keep up with the latest research on curriculum and instruction and work closely with one another in developing creative educational ideas. If a student falls behind, the school has an intelligent intervention program. Parents are actively involved, and resources are devoted to improving the skills of staff members and to finding time to allow them to work together.

Similar instances of remarkable performance have occurred in other California schools. In mathematics, for example, many inner-city, suburban, and rural schools, which have been working together for several years to implement a math program based on thinking, significantly outscored other schools and state averages on the CLAS test.

Is what happened at Bryant and these other schools so extraordinary that it offers no lessons to educators hoping to initiate large-scale efforts to improve all schools? I think not. Many schools have the potential to accomplish what Bryant has done, as long as they are willing to work as hard and as smart – and are given effective assistance.

President Clinton recently remarked that the problem of education reform is not a lack of models of school success. In the past decade, educators have created numerous examples of high-performing schools such as Bryant. What is needed now, the President maintained, are "scaling up" strategies that will get thousands of schools to adopt successful practices. This is a more complex proposition. Indeed, a central assumption of the President's Goals 2000 legislation is that states and districts can effectively mount these strategic assistance efforts.

Unfortunately, many of the country's leaders and experts (and too many citizens as well) don't believe that public school educators are capable of organizing effective efforts to bring student performance up to world-class standards. I think those who hold this view are shortchanging the willingness and ability of schools to change and underestimating the capacity of educators. But if educators don't learn their lessons from the accomplishments, mistakes, and partial successes of the reforms of the past 10 years, these skeptics will be vindicated.

Without receiving much credit, many teachers and educators have already made tremendous progress in constructing the necessary knowledge base to enable us to reach world-class performance goals. Ten years of effort have profoundly altered a growing number of schools and districts and have yielded results that are much more positive than has generally been acknowledged. Student achievement rebounded sharply during the Eighties, even though many of our youngsters still perform substantially below their potential. But in these initial undertakings we have also learned just how difficult the long-term task of transforming our schools will be.

LESSONS LEARNED

Four major principles have emerged from the reforms of the Eighties that should guide the scaling-up strategies of the Nineties.

1. *Any effort to improve schools must be designed to meet the goal of creating an active, thinking curriculum in specific disciplines, and success should be judged by whether increasing numbers of students reach agreed-upon performance standards.* Most efforts to improve schools are not driven by a powerful and specific vision of improved teaching and learning. They are usually too generic and too caught up in trivial issues. Thus they never penetrate deeply enough into the culture of schools to make a difference in the classroom.

Part of the problem is design: reforms are not typically organized around improving teachers' knowledge of content or enhancing their ability to collaborate to improve instruction. Nor have enough schools focused their reform activities on establishing specific performance standards in the basic subjects and then on increasing the number of students reaching those standards.

Four principles emerged from the reforms of the '80s that should guide scaling-up strategies today.

Part of the problem is implementation: rather than confront the hard work of transforming curriculum and instruction, schools settle for discussions of site-based management or generic team-building. They merely go through the motions of reform. Another part of the problem is the failure to devote adequate time and resources to retooling the staff.

Whatever the reasons, the lack of sophisticated curricular and instructional focus has plagued state and district restructuring initiatives, as well as such highly publicized national efforts as James Comer's School Development Program, Henry Levin's Accelerated Schools, and Theodore Sizer's Coalition of Essential Schools. Evaluations of these efforts show that only a few schools have undergone the radical curricular and instructional changes necessary to produce significant improvement in student performance.

If a successful reform effort must be connected to a vision of a more thoughtful, problem-solving curriculum – what Howard Gardner has termed "education for understanding"[1] – has this vision been described in sufficient detail to be used by reformers? Most of the specifics of these powerful educational ideas

A successful improvement effort must do more than merely trot out a few new instructional techniques.

have been developed and refined only in the past decade. But they are increasingly becoming available in useful and comprehensive forms.

Translating this detailed vision of "education for understanding" into classroom reality places great demands on teachers and schools. Teachers must learn the core concepts in a discipline, which should anchor instruction. They also need to know how students learn (or fail to learn) these concepts. They should use more question-driven instructional strategies to force students to encounter these concepts in the context of solving well-designed, powerful problems. Teachers should also make use of cooperative discussion techniques to encourage students to make explicit their ways of approaching a problem. Teachers must teach students to model reality and must be able to connect concept, model, and solution. Finally, teachers need to know what student work meets performance standards and how to keep track of the progress students make in understanding and applying the key concepts of a discipline.

Recent work in the area of educating for understanding has become very sophisticated about how well people understand and can apply some of the concepts they are taught. For example, Howard Gardner laments the fact that most people cannot successfully write a correct algebraic equation describing a situation in which there are 25 students for each teacher. Most will write $25s = t$, because most people do not really understand the central algebraic concept that the letters do not stand for things (students) but for specific numbers of things. Thus $25t = s$ is the correct expression.[2]

Similar failures have been found in all major disciplines. Isabelle Beck and her colleagues found little change in fifth-graders' understanding of the concept of taxation without representation *after* studying the Revolutionary War, and many of the key concepts that science uses to describe the physical or biological world, such as why summer is hotter than winter, never really take. Indeed, a whole raft of essential concepts that we have assumed students learn by taking courses are actually never learned in a way that they can be used in the real world.[3]

These startling findings have immense implications. Curriculum and instructional strategies must change radically if we are going to educate large numbers of students to be able to apply what they learn. Curricular and instructional planning should work backward from the key concepts to be learned. For example, mathematics instruction should start from descriptions of how the adult population misunderstands mathematics and should be organized around the small number of central concepts that constitute numeracy.[4] Math should not be a series of 180 loosely linked lessons, which is the organizational strategy currently in use in most math classes.

Expanding and refining networking efforts will be crucial if improvement efforts are to be scaled up.

2. *School efforts must be collective, not just individual; they must be comprehensive, not piecemeal; and a high percentage of the staff must commit to improving student performance and to making the changes necessary.* A classroom-by-classroom strategy might help change a few individual classrooms, but it will not usually be powerful enough to transform a school. Furthermore, strategies that focus solely on individuals don't address many crucial reform issues, such as organizational change, building a learning atmosphere, or developing a team effort.

Moreover, most school improvement efforts stop far short of a comprehensive approach and settle for partial solutions. Perhaps they focus on team-building skills but neglect curriculum and instruction. Or they might decentralize but ignore accountability. They might educate teachers but forget to change the organization of the school.

A successful improvement effort must do more than merely trot out a few new instructional techniques. There must be schoolwide agreement on what the key concepts of a discipline are and what student work, outcomes, and exhibitions reflect mastery of these concepts.

A successful schoolwide improvement strategy also addresses which questions or investigations effectively force students to deal with the key concepts and which modeling techniques best enable students to connect concept, problem, and algorithm. Such a strategy includes plans on how best to help teachers learn how to keep student discussions focused on central concepts and how to use the opportunities that inevitably arise in group work. In addition, teachers need a means of keeping track of which students are learning the key concepts and how to apply them, as well as a method for rapid intervention with and tutoring of those who are falling behind.

Intelligent reform is complicated and hard, but it is the only way to produce the results being demanded. One example of such reform that focuses on early elementary reading is Success for All, Robert Slavin's program out of Johns Hopkins University. It has compiled one of the best track records of any of the national or state improvement projects because it is consistent with both research findings about and practical experience with how students learn to read, and it is comprehensive and eclectic enough to produce results. A large percentage of the teachers in a school must commit to the basic principles and strategies of Success for All before the school can join. The school or district must also commit substantial resources and time for staff development, for an on-site coordinator to provide the intensive support necessary for success, and for hiring additional reading professionals.

The components of Success for All include a family support team, a very focused and sophisticated instructional approach and organizational scheme for developing reading skills, a method of keeping track of progress, rapid intervention for those not keeping up (with professional tutoring similar to Reading Recovery), a strategy to encourage students to read more books and do more homework, and a strong literature base to encourage the development of comprehension. Most school improvement efforts never reach such a comprehensive level of detail and so don't produce the jumps in performance that are promised.

3. *State- and district-level strategies must be comprehensive and make use of the major leverage points in the education system to create a context in which effective learning communities are developed at each school.* Most state and district improvement efforts are not sufficiently comprehensive or well thought out to produce effective support for change at the school site. One or two pieces of the puzzle may be in place, but the overall support is often too weak to make the necessary changes. States may adopt frameworks without any plan for getting teachers to read and wrestle with them. States may use assessments that are out of sync with a thinking curriculum. Or, if states should happen to create authentic assessments, they don't train teachers in what a particular standard represents or don't put the data in a form useful to schools. (It's extremely helpful to a middle school staff trying to improve writing, for example, to know that only 40% of its students reach at least the third level of writing ability on the CLAS test, while the school next door with the same type of students is able to get 75% of its students to that level.)

However, when enough initiatives start to reinforce one another, a powerful climate for improvement is created. In a recent study that evaluated high school reform efforts in California and Michigan, Milbrey McLaughlin and Joan Talbert found convincing evidence for the idea that a "community of scholars" must be created at each site to think through and implement reforms.[5] However, their most powerful finding was that the climate created by the state (and by the cooperating districts) had a major impact on the number of school-based improvement communities that arose. If a sizable number of teachers in a school are given the opportunity to attend a math education project and the principal and his leadership team have been allowed to enroll in a math leadership program, the chances increase greatly that a critical mass of people in a given school will pick up the reform ball and run with it.

UNIVERSITY LAB
DaveCarpenter

"Hi, I'm Grant. The government sent me."

Any reform strategy that is to be successful must assume that there are plenty of activist teachers, epitomized by Theodore Sizer's Horace;[6] innovative principals; and trail-blazing superintendents who will do what is needed to create the proper context for reform. Too many school improvement projects assume that schools will settle for easy and superficial efforts when the professionals actually in the schools are willing to be much more serious about improving student learning.

4. *Large-scale implementation of school improvement efforts depends on networking strategies that can organize large numbers of schools around a powerful idea for instructional improvement, provide assistance, and allow conversation with sister schools.* Some pundits have argued that site-based governance, choice, eliminating regulatory controls, creating charter schools, or even generalized restructuring efforts by themselves would be enough to spark wholesale implementation by large numbers of schools. While these ideas are important components of a reform strategy, they have not proved compelling enough to engage most schools in the deep discussion necessary to change learning and instruction.

Networking strategies seem much more promising. Successful networks are designed around a powerful theme that focuses attention on instruction and learning; they provide sophisticated nurturing to the schools. Networks bring schools together, which broadens perspectives and offers needed collegial support. Such networking efforts have just begun, but expanding and refining them will be crucial if improvement efforts are to be successfully scaled up.

In the space remaining, I examine Cal-

BEST COPY AVAILABLE

ifornia's attempt to initiate a widespread networking strategy based on the lessons of a decade of efforts to improve schools by educators, parents, public officials, and community members. I offer the California experience in the hope of informing the national discussion of how best to help those already committed to or desiring to improve their schools.

NETWORKING IN CALIFORNIA

The networking strategy in California emerged from two major previous phases of reform.

Phase 1: creating a vision of teaching and learning. The first phase concentrated on creating a vision of a thinking curriculum in each of the disciplines and then promulgating that vision. Frameworks, professional development projects, and discussions were all part of phase 1.

Phase 1 worked amazingly well in California. What used to be the conventional wisdom that only the elite could learn a more demanding instructional program has undergone a sea change in California, and the need to provide all children with "education for understanding" has become the new conventional wisdom.

Phase 2: systemic reform. The second phase of the reform effort in California involved creating a supportive climate for a thinking curriculum throughout the education system. First, the plan was to develop an improvement strategy for each of the places in the system that could influence how things were being taught and learned in classrooms. Second, each of these strategies was designed to reinforce the others; that is, frameworks were built on the vision of a thinking curriculum, and tests, training, and materials reflected those frameworks. A central tactic was building a critical mass of teachers who knew and could use these powerful learning ideas, because frameworks don't mean much unless teachers are given the opportunity to learn and practice what's in them.

This second phase has been labeled systemic reform and is the basis for the state plans envisioned by the new Goals 2000 legislation. The strategies developed in this phase have resulted in genuine change in many schools and districts in California and have created the potential for change in many more.

Frameworks don't mean much unless teachers are given the opportunity to learn and practice what's in them.

Although these phase 2 initiatives – e.g., building a cadre of teachers trained to use a thinking curriculum, providing information to a school on student performance levels, making available better instructional materials, or providing discretionary resources for school improvement to the schools themselves – were enough to result in improvement in some schools, they were not sufficient for most. Unlike Bryant Elementary, with which I began this article, most schools could not or would not develop a specific school-site strategy to weave the many facets of reform into a workable, comprehensive school improvement plan. The plain fact is that most districts did not assist the schools' efforts to do so. This reality led to a search for further approaches specifically aimed at encouraging more schools to adopt the strategies of those that had been successful.

Phase 3: networks. The third phase was a large-scale attempt to link significant numbers of schools through support networks organized around powerful visions or themes for improvement. This approach was designed to extend reform to those schools that were willing to change but were stymied without some organized assistance. It began about five years ago.

Although many of these endeavors are still in their infancy, most people are not aware of the magnitude of these activities or of how many schools have actually started to undergo significant improvements because of them. By early 1994 about one-fourth of the state's nearly 8,000 schools had signed up for one of more than 20 of these state-sponsored networks. In addition, a few schools are involved in some of the national networks mentioned earlier. What is more, many school districts in California have also made use of this networking strategy to institute such successful improvement efforts as Project LEARN in Los Angeles, the Science Leadership Project in San Francisco, and many smaller projects. We in California are starting to learn more about which themes are powerful enough to engage a school in the deep discussion necessary for real change, about what is the proper mix of process and content in reform, and about why some schools catch fire while some never start and others abort.

Some examples will illustrate the extent of the networking effort in California.

- Several task force reports became catalysts for engendering in-depth discussions about how best to improve learning. Out of a thousand middle schools in the state, 226 are connected to learning consortia dedicated to putting into practice the recommendations of the middle-grades task force report, *Caught in the Middle*. One hundred high schools have joined forces to implement the ideas contained in the high school task force report, *Second to None*, and nearly 600 elementary schools paid a dollar per student to become part of the Elementary Alliance, which is dedicated to incorporating the proposals of the elementary task force report, *It's Elementary*.
- Approximately 140 schools received restructuring grants under legislation sponsored by the business community. One out of every five schools in the state submitted a proposal for planning money. A broad-based panel then selected recipients of operational grants. Additionally, one million dollars of technical support was provided to assist grantees. The bill specifically requires schools to figure out how best to accomplish what the frameworks suggest.
- More than 240 middle schools signed up for the Math Renaissance, a reform project funded by the National Science Foundation (NSF), in which the schools agreed to use special math units consistent with the math framework for a portion of a year's math curriculum. The

project provides training, materials, networking, and on-site coaching. Another group of 160 schools begins next year, which means that 40% of all middle schools in the state will be involved.

- More than 1,500 elementary schools are linked in an NSF-sponsored project for the systemic reform of school science, which, like the Math Renaissance project, offers on-site coaching, training, materials, and networking for those elementary schools that are committed to implementing the state science framework.
- More than 50 schools are participating in New Teacher Projects, a cooperative effort that involves universities and districts in supporting and evaluating new teachers. The goal of the project is to reduce the high initial attrition rates in the profession while helping new teachers deliver a high-performance education. Between 1988 and 1992 more than 3,000 new teachers participated.

Obviously, not every school that is taking part in one of these projects is undergoing significant change, and not every one of these themes or strategies is powerful enough to cause increases in student performance. But the surprise is that a large number of these schools are actually engaged in deep, worthwhile improvement efforts.

Although a wide variety of themes can engender the complicated discussion necessary to begin fundamental change at a school, there are several common threads in each of these initiatives: 1) a powerful learning theme, usually expressed in a set of shared beliefs that include the key components of curriculum, instruction, assessment, professional development, and team building; 2) a collective decision by a substantial number of teachers at the school to act on these beliefs; 3) a comprehensive school strategy that includes most of the components necessary for improving student learning; and 4) a sophisticated site-assistance strategy.

Joseph Murphy and Philip Hallinger corroborated these strategies in their analysis of eight school improvement initiatives that were embedded in a supportive network.[7] And, in an evaluation of eight of the original schools in the Coalition of Essential Schools, Donna Muncey and Patrick McQuillan found that, where reforms did not take, no real consensus for change was initially developed; indeed, many teachers who gave lip service to the reforms at the start became hostile when changes threatened to affect them directly.[8] Other preliminary conceptualizations and evaluations of these fledgling efforts are starting to appear.[9] Networking strategies that do build on the initiatives of phase 1 and phase 2 show promise – and, eventually, every school in the country should belong to a specific network dedicated to a potent improvement theme.

"Never say 'correct me if I'm wrong' to a teacher."

CALIFORNIA CONTEXT

Have any of these efforts actually improved the performance of students in California? Although systemic reforms usually take several years to bear fruit, and the educational soil has been particularly rocky in California, the results are much better than one would expect.

In some important ways the climate for education in the state during the 1980s was not conducive to comprehensive reform. Much energy had to be expended just to accommodate the explosive population growth: 1.1 million new students since 1982 (a 25% increase). Immigration steadily rose, so that by 1992 one out of four elementary students had limited proficiency in English (a jump of 50% in just five years), and another one out of six weren't born into families that spoke English. Rates of diversity continued to climb; by 1990 over 54% of the students in the state were members of minority groups, up from 43% in 1980. (Only Hawaii, New Mexico, and the District of Columbia have a larger percentage of minority students.)

Poverty rates and general social disintegration also increased dramatically. One out of four students came from families living below the poverty line, an increase of 66% since 1980. As a result, California rose from 17th in the nation in percentage of families in poverty in the early 1980s to ninth in the nation in the early 1990s. Despite the growing needs, funding during this same period fell precipitously; in the early 1980s the state's per-pupil expenditure was just about equal to the national per-pupil expenditure, but California's funding per student today has dropped more than $1,100 below the national average. Class size is now 29 – seven above the national average.

Just preventing student performance from plummeting under these conditions

Determining how best to cultivate and enhance these expanding networks is the next great project.

would have been a tribute to the dedication and competence of California educators, yet most measures of student performance rose substantially during this period, though some indices finally started to tail off as the full impact of harsh social and fiscal conditions began to be felt. For example, from 1986 to 1992 the number of dropouts declined 33%, from more than one out of four students to one out of six. Meanwhile, the pool of students who met the A-F requirements for the University of California rose by 33% and now encompasses one-third of all high school seniors. The number of Advanced Placement exams taken and passed (a score of 3 or better) tripled to a rate of 22 tests passed per 100 seniors (not just test-takers).

The number of minority students taking the SAT rose from 35% of the total population of test-takers in 1984 to 54% in 1992 (double the national rate), as more students were encouraged to take the test. In addition, 20% of California test-takers (versus 8% in the nation) are not native speakers of English. Yet overall scores remain even with those of the rest of the country (a little higher in math, a little lower in reading). Native-born test-takers in California outscored the nation 490 to 481 in math and 437 to 434 in reading.

From 1982 to 1990 (when the assessment was phased out) the performance of 12th-graders on the tests of the California Assessment Program increased about one full grade level; eighth-grade scores rose an average half a grade between 1986 and 1990 – the year in which they began to tail off as a result of spending cuts and demographic changes. Scores for elementary students in math and reading increased steadily in the middle Eighties, but, beginning in the late Eighties, reading scores lost a significant portion of these gains as non-English speakers and funding cuts took their toll. (A neglect of instruction in basic skills, due to a misunderstanding of a literature-based strategy, probably hurt reading scores as well.) Last year's fourth-grade reading scores on the National Assessment of Educational Progress were very low. Overall, however, California educators deserve praise for significantly raising student performance under difficult circumstances in the early Eighties and for maintaining as much of these gains as possible under increasingly difficult conditions. Their successes in the face of long odds provide powerful support for the efficacy of the California strategy.

Phase 3 networking initiatives in California have shown great promise for engaging large numbers of schools in the difficult process of genuine school improvement. Phase 4 is just now starting. It involves, first, a systematic discussion of how best to assist schools that wish to attempt the kind of change delineated above. Much craft knowledge has been acquired in each of the previous phases of California reform and in other efforts around the nation. But the systematic comparing of notes has not occurred. For example, how much investment in the professional development of teachers must there be? Four weeks during the summer? Periodic sessions during the year? Or joint planning and visitation time? How intense should coaching support be? Is a coach who comes one day or even half a day a week enough to produce results, or do you also need an onsite facilitator/leader, as is the case in Success for All? What is the proper mix of process and content approaches? And what kinds of materials are best suited to assist school-based improvement efforts?

Second, those dedicated to improving our schools need to garner the support of the educational and political communities to provide the legitimacy, resources, and expertise needed to help multiply such efforts. Soon, every school in the nation should be attempting to provide a successful "education for understanding" to its students. The most disappointing and dangerous aspect of systemic reform is how few outside of educational circles even know that this widespread effort exists. Indeed, those crying loudest for improved results may, out of ignorance, cripple the best strategies for achieving significant improvement. Determining how best to cultivate and enhance these expanding networks is the next great project in the continuing and crucial effort to remake public education.[10]

---

1. Howard Gardner, *The Unschooled Mind: How Children Think and How Schools Should Teach* (New York: Basic Books, 1991). See also David K. Cohen, Milbrey W. McLaughlin, and Joan Talbert, eds., *Teaching for Understanding: Challenges for Policy and Practice* (San Francisco: Jossey-Bass, 1993).

2. Gardner, pp. 160-61.

3. For a fascinating description of this work in cognitive science, see John T. Bruer, *Schools for Thought* (Cambridge, Mass.: MIT Press, 1993).

4. See John Allen Paulos, *Innumeracy: Mathematical Illiteracy and Its Consequences* (New York: Farrar, Straus & Giroux, 1989).

5. Milbrey W. McLaughlin and Joan E. Talbert, *Contexts That Matter for Teaching and Learning* (Palo Alto, Calif.: Center for Research on the Context of Secondary School Teaching, Stanford University, 1993).

6. Theodore R. Sizer, *Horace's School: Redesigning the American High School* (Boston: Houghton Mifflin, 1992).

7. Joseph Murphy and Philip Hallinger, eds., *Restructuring Schooling: Learning from Ongoing Efforts* (Newbury Park, Calif.: Corwin Press, 1993), Ch. 10.

8. Donna E. Muncey and Patrick J. McQuillan, "Preliminary Findings from a Five-Year Study of the Coalition of Essential Schools," *Phi Delta Kappan*, February 1993, pp. 486-89.

9. William H. Clune, "The Best Path to Systemic Educational Policy: Standard/Centralized or Differentiated/Decentralized," *Educational Evaluation and Policy Analysis*, vol. 15, 1993, pp. 233-54; Michael Fullan, *Change Forces: Probing the Depths of Educational Reform* (Bristol, Pa.: Falmer Press, 1993); Carl D. Glickman, *Renewing America's Schools: A Guide for School-Based Action* (San Francisco: Jossey-Bass, 1993); Ann Lieberman and Milbrey W. McLaughlin, "Networks for Educational Change: Powerful and Problematic," *Phi Delta Kappan*, June 1992, pp. 673-77; and Phillip C. Schlechty, *Schools for the Twenty-First Century: Leadership Imperatives for Educational Reform* (San Francisco: Jossey-Bass, 1990).

10. As one small contribution to that end, I have created the Center for Systemic School Reform, funded by the Koret and Goldman Foundations and located at Burk Hall 221, San Francisco State University, 1600 Holloway Ave., San Francisco, CA 94132. Ph. 415/338-3059. (E-mail: cssr@sfsu.edu). Readers who have information or thoughts about the issues discussed in this article or who wish to obtain a copy of a longer version of this article, which goes into more depth on each of the programs cited and describes a variety of other California programs, are invited to contact me. K

BEST COPY AVAILABLE

18 EXPANDING OUR UNDERSTANDING OF SYSTEMIC CHANGE

Audience:

- Individuals responsible for designing and supporting change in science and mathematics at all levels.

Desired Outcomes for Participants:

- To discuss a number of different current perspectives on the concept and approach to systemic change.

Materials:

- **Handouts:**
  - *Questions for Expert Groups* (18-5)
  - *Questions for Home Groups* (18-6)
- **Readings:**
  - "Putting the Pieces Together: Systemic School Reform" in *CPRE Policy Briefs* by Marshall S. Smith and Jennifer O'Day. New Brunswick, NJ: Consortium for Policy Research in Education (CPRE), April 1991, 1-10.
  - Excerpt from "Science Education for the 1990s: Reflections on a 1991 Wingspread Conference" by Mark St. John. Inverness, CA: Inverness Research Associates, 1992, 37-51.
  - "Recapturing the Spirit of Learning Through a Systems Approach" by Peter Senge and Colleen Lannon-Kim. *The School Administrator*, November 1991, 48 (9): 8-13.
  - "Innovation, Reform, and Restructuring Strategies" by Michael Fullan. In Gordon Cawelti, ed., *Challenges and Achievements of American Education*, The 1993 Yearbook of the Association for Supervision and Curriculum Development. Alexandria, VA: ASCD, 116-133.
  - *(Optional)* "Assessing Progress Toward Systemic Reform: Improving Mathematics and Science Learning" by Douglas S. Fleming, Barbara A. Fleming, and Charles Mojkowski. Chelmsford, MA: Schools Strategies and Options, 1994.
- Newsprint, easels, markers, tape, and pens or pencils

Time Required: Two and one-half to three hours

Facilitator's Notes: Thus far in the *Toolkit*, activities have helped participants understand the major ideas behind systemic thinking and systemic change. This activity seeks to broaden those understandings as well as complicate them. This is because there are many views of systemic change out there and, while they all seem to contribute to a richer understanding, it's easy to get lost in the verbiage. This activity is an effort to help make participants "streetwise" as they explore some of the major writings and writers on this topic.

A note about the readings chosen for the jigsaw. In many science and mathematics circles, particularly at the national and federal policy and funding level, the definition of "systemic" used is that discussed in the Smith and O'Day summary. There, systemic means coordinated, coherent, and aligned. How do science and mathematics activities that are "systemic" differ from those that are more project-like? This more specific question is well illustrated by the St. John excerpt. If systemic change is reform, which most believe, then the various dimensions that make up reform need to incorporate a systemic perspective. This subject is addressed by Fullan, whose work has moved over time from a focus on implementing programs to changing systems. Finally, systemic change advocates refer often to Peter Senge's book, *The Fifth Discipline: The Art and Practice of the Learning Organization*, yet the book is substantial and it is often not obvious what the connection is. The short education-oriented article by Senge and Lannon-Kim makes the connection clear – systems thinking is required for our schools to become learning organizations – organizations whose people have a clear focus and an orientation towards ongoing inquiry and collaborative development. These are critical attributes of systemic change.

Systemic approaches to change are as yet untested; they are currently in the experimental stage. Yet educators at every level, involved in all content areas, are talking about, designing, and "implementing" systemic approaches. It is the purpose of this activity to further inform the involvement of our participants in these "back-home" efforts.

Process:

1. Describe the rationale for this activity as discussed above. Explain the jigsaw technique (see **Appendix B-3**). Participants begin in groups of four. This is their home group. Each member of the group selects an article to become "expert" in (the last article in the list of **Readings** is for Step 6). Allow reading time, approximately 30 minutes.

2. Have those who read the same article assemble in expert groups of four or five. Distribute the handout **Questions for Expert Groups**

(18-5) and allow 30 minutes for the expert groups to discuss the questions and prepare to "teach" the other members of their home groups.

3. Ask participants to reassemble in home groups. Distribute the handout **Questions for Home Groups (18-6).** (See Step 5 for an alternative way to process the material.) Each member "teaches" their article for seven to ten minutes. Then they discuss the home group questions – allow approximately one hour for the entire home group meeting.

4. Groups then display their newsprint and report out their discussion of the questions with the *. Ask for summary observations or insights.

5. As an alternative to the home group discussion, you can provide the groups with a scenario for them to respond to. Although these scenarios will need to be created for each participant group, here are some examples developed for a teacher leadership cadre. The groups working on each scenario had two people who had read each article. They reported out by sharing products from each group.

   Scenario 1: Your state is about to write a proposal for a State Systemic Initiative grant from NSF. The grant is $2 million for each of 5 years, $10 million in all. The challenge is to move the state science and mathematics reform forward in a way that reaches classrooms but also builds a statewide support structure to sustain the changes. Your leadership cadre is invited to be part of the proposal planning team. Before the first meeting, you meet to decide what you would like the key features of the initiative to be. Because there are university and state people on the committee, you want to back up your list of key features with citations from the literature. Develop a list of key features for the SSI proposal.

   Scenario 2: Your leadership cadre has been nominated for the first-ever President's (of the United States) award for groups that promote systemic reform in science and mathematics education. The award carries with it $50,000 for continued cadre work and a $1,000 bonus for each team member. You need to persuade the committee making the final decision that YOU are the ones. Because the committee has university professors on it, you know that back-up citations from the literature will help your case. Develop an argument for why your leadership cadre should get this award.

   Scenario 3: Your leadership cadre has been invited by the major state newspapers to take a whole page and write an Open Letter to the *public about what it will take to increase science and mathematics literacy in the state. You know that the publishers who invited you respect the literature (their education advisors have doctorates from Stanford and Harvard), so you want to be sure that your ideas are backed up by citations. How would you respond to this request? What would be the key points in the Open Letter?*

6. *(Optional)* Participants may be interested in a tool to assess progress toward systemic reform in a school. If so, hand out copies of the reading, "Assessing Progress Toward Systemic Reform: Improving Mathematics and Science Learning."

7. Ask participants to reflect on, talk about, and/or write: What have I learned in this activity? How can I use what I've learned?

QUESTIONS FOR EXPERT GROUPS

1. What is the definition of systemic change used (either explicitly or implicitly) in the reading?

2. What are some things you would see if systemic change, by this definition, were occurring? (How would you know it if you saw it?) If you think your reading refers to just one or a few of these levels, confine your answers to only those.

   At the level of the learner?

   At the classroom level?

   At the school level?

   At the community level?

   At the state level?

   At the national level?

3. What are some things in your own work that would have to change if it were to be more "systemic" in nature, as defined by this article?

4. What are the main points in this reading you want to be sure to "teach" the other members of your home group? How will you teach them?

QUESTIONS FOR HOME GROUPS

1. What are the definitions of "systemic change" used by the different authors? Assemble them on newsprint. What are the similarities and differences?

2. How do the different perspectives on systemic change reflected in the articles show themselves at the various levels (learner, classroom, school, etc.)? Assemble the images on newsprint. What are the similarities and differences?* Do you observe anything interesting? Strange or unexpected?*

3. What are implications for your own work in science and mathematics reform? Assemble a list of how your work would need to change to be more "systemic."*

*Aside from displaying your newsprint, these are the items you will report out to the large group.

CPRE POLICY BRIEFS

REPORTING ON ISSUES AND RESEARCH IN EDUCATION POLICY

Reprinted with permission of the Consortium for Policy Research in Education from CPRE Policy Briefs by Marshall S. Smith and Jennifer O'Day. (c) 1991, 1-10.

Putting the Pieces Together: Systemic School Reform

This issue of **CPRE Policy Briefs** summarizes "Systemic School Reform," by Marshall S. Smith and Jennifer O'Day,[1] which appears in full in *The Politics of Curriculum and Testing*, edited by Susan Fuhrman and Betty Malen (Falmer 1991).

"Systemic School Reform" is an analytic essay which draws on research conducted by CPRE and others about the effectiveness of current education policies. The author also looked at developing policy systems in a number of states. Smith and O'Day propose a design for a systemic state structure that supports school-site efforts to improve classroom instruction and learning. The structure would be based on clear and challenging standards for student learning; policy components would be tied to the standards and reinforce one another in providing guidance to schools and teachers about instruction.

In a manner similar to the strategy proposed by "Systemic School Reform," a number of states are coordinating various policies to send coherent messages to schools about instructional goals. California, for example, has developed curriculum frameworks that promote problem-solving and complex thinking. Assessments of student performance tied to the frameworks are being developed and phased in. California's practice of statewide textbook adoption makes it possible to assure that grades and textbooks conform to the state's content goals. The state is also beginning to tie staff development efforts to the content frameworks.

Similarly, Connecticut is developing new state-of-the-art assessments tied to a common core of learning. New York's Regents Testing System provides a mechanism of reinforcing content goals with assessments. Kentucky and Vermont also appear to be moving in the direction of coherent instructional guidance.

These developing policy systems raise many questions. How is consensus within states about content goals developed and sustained? How detailed are the curriculum guidance policies and what room do they leave for school flexibility? How do the systems evolve over time to incorporate new knowledge, especially in rapidly developing fields like student and teacher assessment? How are they implemented by schools and teachers? How do these policies accommodate the diverse needs of students, schools and communities? Are the messages sent by policy reinforced by families, communities, employers and colleges?

These questions and the analytic foundation provided by "Systemic School Reform" underlie a number of studies CPRE is conducting. We will report our findings in subsequent briefs about systemic reform efforts. In the interim, we hope this brief is useful to policymakers and educators thinking about the relationship between state policy structures and school-based improvement.

This brief follows the general organization of "Systemic School Reform," which begins with several observations about policy and school-level success, examines current barriers to school improvement, and then sketches out a strategy to improve the quality of instruction and learning. A sidebar on page 3 of this brief deals with the relationship between the strategy and two important issues: teacher professionalism and educational equity.

---

[1] Marshall S. Smith is dean of the School of Education at Stanford University and a member of the Consortium for Policy Research in Education (CPRE) Management Committee. Jennifer O'Day is a doctoral student at Stanford and a research assistant at CPRE.

CPRE CONSORTIUM FOR POLICY RESEARCH IN EDUCATION

Rutgers, The State University of New Jersey
University of Southern California · Harvard University
Michigan State University · Stanford University
University of Wisconsin-Madison

RB-06-4/91

BEST COPY AVAILABLE

Successful Schools and Educational Policy

For the last 10 years, education reform has been at the top of the nation's agenda. However, while many individual schools in school districts of all sizes and types made remarkable progress, the system as a whole did not improve. In fact, the decade ended with little evidence of meaningful gains in learning (Mullis and Jenkins 1990) and heightened concern about the productivity of education and of the nation as a whole.

Many analysts attribute the meager results to the very nature of reform efforts in the early 1980s, which they characterize as "top down" and "more of the same." These efforts included longer school days; increased requirements for graduation from high school; higher standards for teachers; and more testing for students— focusing primarily on competence in basic skills. These reforms did little to change the content of instruction, directly involve teachers in the reform process, or alter the reigning notions of teaching and learning (Cohen 1990; Carnegie Forum 1986; David et al. 1990).

Largely in response to these deficiencies, a "second wave" of reform rhetoric began building in the mid-to-late-1980s calling for a fundamental rethinking and restructuring of schooling, not a bolstering of the existing system. The key concepts of this second wave are decentralization, professionalization and a bottom-up process with the school as the basic unit of change.

The rhetoric often points to characteristics of successful schools suggested by both research and common sense: a staff of enthusiastic and caring teachers who have mastered both subject matter and a variety of pedagogies for teaching it; a well-organized, challenging curriculum, integrated across grade levels and appropriate for students of diverse experiences, cultures and learning styles; a high level of teacher and student engagement in the educational mission of the school; and ample opportunity for parents to support and participate in the education of their children. Most of the second wave reforms seek to move schools toward this or similar images of "success" by placing authority in the hands of school personnel.

While the full effects of many restructuring reforms are yet to be seen, it is not too soon to see that a school-by-school approach is not likely to result in substantial change of the type needed in nearly all schools. Why not? What makes it so difficult to generalize success in our educational system and why are successful schools so exceptional and vulnerable? Two major factors provide some of the answers:

1. Our educational system lacks coherence.
2. A basic skills emphasis still pervades both policy and practice.

Lack of Coherence in the Educational System. Our complex, multilevel governance structure, with a number of separately constituted centers of authority at each level, frustrates purposeful coordination. The policy generation machines at each level and within each level have independent timelines, political interests, multiple and changing special interest groups, and few incentives to spend the time and energy to coordinate their efforts. As a result, policies compete, overlap and often conflict.

Over the last 10 years, policy fragmentation has worsened. Education's political visibility put a premium on distinctive policy, which generates political credit for the author, over policy integration. The unprecedented volume of policy activity–at all levels of government[2]–heightened the likelihood that policies would not be integrated. Even policies emanating from a single level, the state, sent conflicting signals. For example, entry-level standards for teachers were raised at the same time loopholes to address shortages were created (Darling-Hammond and Berry 1988; AACTE 1985; Sykes 1990). Further, states developed K-12 curriculum policies and teacher professional development policies on parallel, nonintersecting tracks. It was not uncommon, for example, for state mandated or recommended teacher evaluation instruments to ignore content goals for students.

Policymaking frequently exhibits a "project" mentality, whereby each problem is addressed with a distinct special program. A new classroom management system, an inservice day on the "left and right brain," a new laboratory filled with computers but little appropriate software, a tougher attendance policy, a new evaluation and accountability policy, are all familiar concepts or "solutions" to the nation's teachers. Some efforts may be very promising for as long as they last, but most are short-lived "projects" to be replaced by a different "concept," a new panacea. Few leave much of a lasting trace.

---

[2] See Darling-Hammond and Berry (1988), Firestone, Fuhrman and Kirst (1989), and Coley and Goertz (1990) for reviews of state-level policy activity. For discussions of activity at the local and national levels respectively, see Fuhrman and Elmore (1990) and Smith, O'Day and Cohen (1990).

Policy fragmentation is a source of significant dissatisfaction to school personnel who feel great responsibility for educational improvement but frustration over the mixed signals and the complex administrative requirements that attend individual programs. A recent Education Commission of the States survey of state and local leaders in 11 states found that "the variety of reforms and not knowing which works sends confusing messages to school leaders and impedes the will to change" (ECS 1990, 1). As a result, school officials may ignore or subvert some policies. Dedicated and well-meaning school personnel find that the array of mandates, guidelines, incentives, sanctions and programs drain their energies from serious school improvement.

An Emphasis on Basic Skills. Neither the first or second wave reforms have altered on a broad scale the inadequate models of teaching and learning that currently define the content and pedagogy of American education.

For all the effort expended in reform, the processes and content of instruction in most public school classrooms of today are little different from what they were in 1980 or 1970, containing little depth or coherence, emphasizing isolated facts and "basic skills" over opportunities to analyze and solve problems (Cohen 1989, 1990, 1991; Cuban 1990).

Some state policies of the early 1980s intentionally built on the "back to basics" emphasis that began in the late 1960s. For example, states instituted minimal competency tests that focus on low-level skills and standards and mandated or encouraged the use of such tests as criteria for promotion and graduation. Other statewide policies had the same effect without such purposeful intent. For example, accountability systems attached more and more consequences to scores on standardized tests that emphasize broad coverage of unconnected facts and the ability to quickly find the one, right answer to a series of unrelated, multiple choice, limited time-span items. Most "first wave" reforms simply "intensified" current practice (Firestone, Fuhrman and Kirst 1989), emphasizing quantity in terms of numbers of courses or length of school day, rather than quality.

Systemic Reform and Two Key Issues

Teacher Professionalism

A common criticism of state curricular reforms is that they diminish the sense of professionalism, and, therefore, the effectiveness of teachers by restricting their autonomy and authority to control the content of instruction in their classroom (McNeil 1986; Sykes 1990). The reforms proposed in "Systemic School Reform" would focus on core conceptions of knowledge and skills to be acquired over several years of schooling; they would not spell out detailed curricula that might stifle teacher creativity.

Moreover, part of the power of a coherent system is that the knowledge and skills in the state content frameworks would provide a basis for "expert knowledge" as well. The frameworks would define fields of knowledge that competent professionals would command. Mastering the content and how to teach it would truly "empower" teachers, setting them apart from almost everyone in society by virtue of their sophisticated knowledge base, and giving them a common basis for professional dialogue. In addition, teachers and other subject-matter experts would provide the professional expertise necessary to develop, refine and update the state curriculum frameworks.

Educational Equity

Exclusive reliance on school-based change is likely to disadvantage minorities and the poor. Districts and schools with large numbers of such students often have less discretionary money to stimulate reform and more day-to-day problems that drain administrative energy. A systemic state reform strategy would insure that changes toward newer conceptions of curriculum and instruction are available to all groups, more or less equally. Local discretion and professional judgment within the structure of common curricular frameworks would allow teachers the flexibility to meet the varying needs of their particular students and still hold them to common goals for all children.

Unless curricular reforms are buttressed by a coherent state system that links teacher training, teacher certification, the curriculum and testing together into a structure within which we can legitimately hold schools accountable, we will surely enlarge the differences that continue to exist between the quality of instruction available to rich and poor, minority and majority students.

Many restructuring efforts speak of complex problem-solving and higher-order thinking but focus primarily on site-based management, shared decision-making and professional collaboration. While important elements of the change process, alone they will not produce the kinds of changes in content and pedagogy that appear critical to our national well-being (Fuhrman, Clune and Elmore 1988; Elmore and Associates 1990; Clune 1991). Even more importantly, the policy system does not provide support to teachers and other school-level reformers for significant improvements in teaching and learning.

The Current System and Barriers to Change

Fragmented authority structures and multiple short-term and often conflicting goals and policies provide little support for school improvement. Smith and O'Day examine how major components of educational policy reflect, and in fact reinforce, the incoherence of the system, inhibiting change efforts.

BEST COPY AVAILABLE

Teachers are not prepared with the kinds of knowledge and skills required if schools are to change to deliver more challenging curriculum. The disjuncture between teacher knowledge and teaching practice begins with the entrenched condition of teaching in the nation's postsecondary system. Prospective teachers learn the content of arts and science disciplines in courses outside of schools of education that are generally taught in a lecture style, fact-oriented fashion.

In many large colleges and universities, courses in mathematics, science and history typically have examinations with short-answer, machine-gradable questions, while literature courses require papers of only a page or two. Licensing and certification systems focus on evidence of adequate credit accumulation in content areas; current tests of prospective teachers typically represent only weak attempts to ensure that prospective teachers have the knowledge of content and skill in pedagogy to do an effective job in the classroom (Smith and O'Day 1988).

The condition of inservice professional development is little better than that of preservice training. Inservice systems are built primarily on graduate credit requirements for continuing certification and salary increments. Because of a lack of coordination between higher education institutions and K-12 school systems, teachers typically take courses badly coordinated with the demands of their jobs. The content of these courses often depends more on the intersection of the teacher's schedule with the interests of professors in local institutions than on the needs of K-12 students.

Professional development experiences organized by schools or districts are generally more closely attuned to the specific needs of schools but limited in scope and duration, frequently lasting a day or less only once or twice a year. Only rarely are they sufficient to help teachers make major changes in their approach to instruction. Furthermore, the federal, state and local budgets for inservice professional development are small and extremely vulnerable to budgetary constraints (Guskey 1986; Little et al. 1987; McLaughlin 1990).

Current curricula and instructional materials also provide little support for improvements in content and pedagogy. Teachers and students alike find the materials uninteresting and unimaginative. Both students and their future employers complain that school learning bears no connection to real life experience or problems.

The fragmented policy system contributes to the poor quality of curriculum materials. Diffuse authority structures and multiple goals within the system foster mediocrity and conservatism both in the publishers' supply of curricular materials and in the demand generated by local educators. Inconsistent policy results in textbooks that merely "mention" topic after topic, covering each so superficially that the main points and connections among them are often incomprehensible to the student (Tyson-Bernstein 1988; Newmann 1988).

Educators must respond to the same conflicting demands and lack of common goals as the publishers, leading many to unintentionally support and perpetuate mediocrity in content by choosing materials that are comfortable (familiar), easy to work with pedagogically (fragmented, factual, simple), and that lead to the most manageable classrooms (again, fragmented, factual, easy to monitor).

Indeed, as ironic as it may seem, this situation has actually contributed to the development of a common instructional practice and a common basic skills curriculum. The emphasis on basic skills has contributed to a significant educational success—considerable progress since 1980 in closing the gap between minority and

white students on measures of national achievement (Smith and O'Day 1991). But basic skills are not sufficient to meet employers' needs in the future. Nor is a democratic society well served by schools focusing on narrow conceptions of knowledge.

Furthermore, rigid hierarchical models of learning, where basic skills are presumed to be the foundation of more complex skills, are outmoded and inconsistent with what we know about how people learn. According to Resnick (1988, 45), the most important single message of recent cognitive research is that:

> Complex thinking processes—elaborating the given material, making inferences beyond what is explicitly presented, building adequate representations, analyzing and constructing relationships—are involved in the most elementary mental activities... all of this implies that no sharp separation between "basic" and "higher order" skills can be made.

While educators and observers have recognized and written extensively about the inadequacy of rigid models of learning and the curricula they engender, the fragmentation of the policy system makes substantial, widespread change in instructional practice and the curriculum virtually impossible.

Without a supportive policy structure, innovations emerge but soon die out. Teachers or schools experiment with particularly creative and promising curricula and instructional practices, often with considerable success. But most of these innovations become marginalized or disappear altogether. Programs developed in one sector (e.g., curriculum) are rarely linked to the extensive necessary changes in other sectors (e.g., teacher professional development). School-based innovations are frustrated by policies sending conflicting signals. For example, school efforts to introduce more challenging curricula can be stymied by district or state assessments focusing on basic skills.

Even if some schools succeed in developing and sustaining curricular and pedagogical improvements, the lack of system support makes it virtually impossible to generalize changes from a small number of initially active schools to the well over 100,000 educational institutions across the country. Furthermore, the schools most likely to innovate are often the ones serving the most advantaged; the schools serving less-advantaged children frequently get left behind.

The need to improve (beyond basic skills) as an entire nation, concerns about equitable improvement for all, growing frustration with policy fragmentation, and increasing understanding about how children learn all signal that the next step in reform needs to be system-wide encouragement of ambitious, high quality outcomes. Smith and O'Day argue that we need to put the pieces of reform together in a coherent system that combines the vitality and creativity of bottom-up change at the school site with an enabling and supportive structure at more centralized levels of the system.

A Strategy for Systemic Reform

Both approaches to reform seen in the 1980s, top-down and bottom- up, are inadequate when pursued in isolation. Smith and O'Day propose a strategy for system-wide improvement that combines both approaches in a supportive policy structure that can provide direction for school-level changes and make such changes more easily adaptable to different situations. The strategy includes three major components: a unifying vision and goals, a coherent instructional guidance system, and a restructured governance system.

The policy structure is a function of state leadership. If we wish to influence more than a few schools or districts at a time, the state is a critical actor. States are in a unique position to provide coherent leadership, resources and support to the reform efforts in schools. Not only do they have constitutional responsibility for education, states are the only level that can influence all parts of the K-12 system and affect the way in which state systems of higher education might operate to help the K-12 system.

States also represent markets of sufficient size to leverage improvement in aspects of education that are outside of the system itself, such as textbook and materials development. Furthermore, states have improved in capacity for educational policymaking and have gradually amassed greater authority and responsibility over their educational systems. Increasingly, concerns about the economy and productivity of the state provide incentives for policymakers to exert educational leadership.

A Unifying Vision and Goals. To provide coherent direction for educational reform throughout the system, a state must have a common vision of what schools should be like. The vision should be informed by underlying values concerning intellectually stimulating and engaging education for *all* students. Broad conceptions and values, however, will not be enough. We need goals that can be communicated and measured if we are to mobilize the political support necessary over time.

Some goals might address desired changes in the nature or quality of educational inputs, such as the quality of the teaching force. The most powerful goals, however, would be those related to students. Statewide student outcome goals should focus primarily on the core functions of the system; that is, on teaching and learning. And, to meet the demands of the future, they must go well beyond the "basic skills" goals of the 1960s, 1970s and early 1980s. They must challenge the system to prepare our youth to grapple thoughtfully with those problems that defy alogrithmic solutions and to be skilled and confident learners in school and later on. Moreover, the goals and indicators must address not only the average level of opportunity and student achievement in the state but also the variation. Justice requires that the goals of the state promote equality as well as quality.

A Coherent System of Instructional Guidance. The first step in developing a coherent system of instructional guidance is to work toward agreement on a core body of challenging and engaging knowledge, skills and problem-solving capacities as goals for all students. All state policies guiding instruction would be based on these goals, forming a consistent, supportive policy structure for school improvement. Overcoming the fragmentation of the system requires coordination of the key elements affecting instruction: curriculum and curricular materials, preservice and inservice teacher training, and assessment.

Curriculum Frameworks

The basic drivers of the system would be curriculum frameworks which set out the best thinking in the field about the knowledge, processes and skills students need to know in each core curriculum area. The frameworks would emphasize depth of understanding, knowledge construction through analysis and synthesis of real life problems, hands-on experiences, and the integration of content and pedagogy. Highly qualified teams of teachers and disciplinary experts would develop the frameworks and participate in continual updating and review.

It is important to distinguish the notion of core curriculum frameworks from the more specific curricula actually taught in the schools and classrooms. The frameworks would set out themes, topics and objectives in sufficiently long-range chunks (e.g., four-year blocks) to allow maximum flexibility and creativity at the local level while establishing clear direction for the system. California is illustrative of a state that has already developed quite progressive curricular frameworks in a number of areas. They reflect the problem-solving and higher-order thinking orientation of recent reform reports (see for example, NCTM 1989; AAAS 1989), but do not detail a day-to-day, week-to-week, or even a month-to-month curriculum for teachers to follow. Instead, for the most part, they describe outcomes expected at the end of certain periods of time, such as the 4th, 8th and 11th grades.

The frameworks would provide a structure within which to organize the other important educational components. Teacher professional development programs, both preservice and inservice; teacher licensing programs; textbook and curricular materials; and testing systems should all reflect the content of the frameworks. For the frameworks to provide the type of guidance necessary to improve instruction, they must be of the highest quality possible. Only if this condition is met will they command the respect and enthusiasm of capable teachers. Furthermore, local school personnel must have freedom within the frameworks to interpret and implement instructional strategies that most effectively meet the needs of their students.

Curricular Materials

Schools must have the ultimate authority to select and/or revise and develop curricular materials. However, the state has both the responsibility and the potential leverage to assure that there is an adequate supply of

high quality textbooks and other materials that are in line with both the letter and the spirit of the frameworks, so that teachers do not have to reinvent the wheel for every subject and every grade. States could establish a statewide adoption system that emphasizes both quality and coordination with the frameworks and stimulate private and local school development of innovative ways of teaching the core concepts, including software.

Professional Development

States must ensure that both new and practicing teachers have the content knowledge and instructional skills required to teach the content of the frameworks. Although there has been much recent ferment about improving teacher education, no major national reform effort has deliberately addressed the substantive needs of teachers beyond listing general course and degree requirements.

Given the historic independence of higher education from K-12 education, the main leverage for improving preservice education is likely to come from the state's authority to screen and credential teachers rather than from regulation of colleges and universities. Assuring that prospective teachers have the knowledge and capacity to teach well the content in state curriculum frameworks probably requires that states develop strong, progressive performance assessments based on the K-12 content objectives. Faculties in both Schools of Arts and Sciences and of Education would likely alter their courses and perhaps even their own pedagogical approaches to help insure that their graduates succeed on the new state licensing examinations.

Inservice professional development must be a key component of the overall instructional guidance system as most current teachers will remain on the job during and after the implementation of the new frameworks. States could support opportunities for both individual teachers and groups of teachers to develop and refine expertise in the content of the state frameworks and in effective pedagogical approaches. Policymakers could influence the supply of programs by allocating funds directly into program development or by providing incentives for independent organizations, such as universities or libraries, and for subunits, districts and schools, to develop programs. Demand for professional development may be influenced by continuing licensure requirements and accountability systems that encourage teachers to be knowledgeable in relevant areas of the frameworks and in effective pedagogy.

Accountability Assessment

A key component of a coherent instructional guidance system is a high quality assessment system based on the state curriculum frameworks. The assessments should monitor progress toward achievement goals for accountability and stimulate and support superior instruction, functions that cannot be served by most current assessment systems. Most places now use standardized norm-referenced tests which are purposefully divorced from the curricula of the schools and cannot measure what schools are supposed to teach.

New assessment instruments tied to state content frameworks would replace such tests, and, to avoid testing overload, they should be given infrequently. Examinations at three levels—say at the 4th, 8th and 11th grades— would provide adequate information for monitoring and at the same time provide teachers and schools a clear idea of expected outcomes. In addition, allowing for choice among examination questions, as in the current Advanced Placement exams, would allow for variation in school program, teacher expertise and student interest.

Assessment instruments require attention and support commensurate with the important role they play in the system. While current standardized and minimum competency tests reinforce teaching toward an emphasis on isolated facts and basic skills, state-of-the-art examinations based on well-designed curriculum frameworks could help encourage instruction toward higher-level goal such as depth of knowledge, complex thinking, and ability to respond to problems and produce results.

In summary, curricular materials, teacher professional development, and assessment systems based on high-quality curriculum frameworks would provide the kind of guidance to schools that would support improvements in content and pedagogy. Coordination of these various policies transforms them from a set of unrelated, or, even worse, conflicting, messages to schools into a coherent system of instructional guidance. Tying these policies to challenging content outcomes provides leadership for classroom innovations designed to enhance teaching and learning.

A Restructured Governance System. The proposal for a coherent state system of instructional guidance comes in the midst of a long-standing but increasingly intense debate about the compatibility of centralized policy decisions on the one hand and professional discretion on the other. In fact, much of the current literature on school improvement, especially the restructuring literature, assumes that centralized policies regarding curriculum and instruction serve to undermine school personnel's efforts to improve. Smith and O'Day argue that negative effects of centralized policies relate in large measure to their fragmentation and their encouragement, deliberate or inadvertent, of traditional and no longer productive, narrow conceptions of teaching and learning.

The strategy outlined above proposes a change in both the coherence and goals of state policies so that they may set the conditions under which teacher empowerment, professionalization, and school-site management may flourish. The state would provide a clear picture of long-range goals coordinated across the various instruments of state policy but avoid dictating school curricula and activities. State activities would focus on the challenging tasks of developing consensus about learning goals, crafting policies that consistently reflect and reinforce the goals and providing support to schools in reaching the goals. School-level personnel would develop specific curricula, programs and pedagogies designed to achieve the goals.

Establishing divisions of authority that draw on the strengths of each level of government requires a rethinking of traditional responsibilities, a redesign of governance. Since the major responsibilities of the state in constructing a coherent guidance system have already been described, the following sections focus on the school, upon which the success of this enterprise ultimately depends, and the district, which must offer the school maximum support.

Governance at the School Building Level

Schools obviously have many responsibilities, but with respect to achievement on the state content goals, the school's primary job is to develop a stimulating, supportive, and creative environment to maximize achievement. The restructuring literature and older literature on effective schools suggest three practical ingredients for instructional success: a staff of well-trained professionals who could use their knowledge and experience to follow the best practices appropriate to their students to meet state goals; an internal governance structure that grants those closest to students, the teachers, important decision-making roles and time for collaborative planning and reflective and professional development activities; and hardware and resources necessary for productive, professional workplaces (Purkey and Smith 1983, 1985; Cohen 1983; Elmore and Associates 1990).

These ingredients have strong governance implications for schools. They suggest that schools need sufficient autonomy to shape their programs to meet local conditions and the needs of their students, and that the selection of staff, inservice strategies, curriculum (within the state guidelines) and pedagogies should be done at the school site. They also underscore the importance of teacher participation in school decision making and the need for teachers to have time and facilities for collaborative activities in service of improved instruction. Such school-based changes are the focus of many current restructuring experiments. Smith and O'Day' argue that, while these elements are fundamental to improvement, without the changes in the policy structure proposed previously, they will not lead to meaningful or sustained change in teaching and learning.

New Book Examines Curriculum and Accountability Policies

"Systemic School Reform," is just one chapter of a new book that looks at some of the most crucial issues in education today.

The book is organized into three sections. Section 1 describes state-level changes in curriculum policy and assesses the initial impacts of policy changes at different levels of the system. Section 2 focuses on changes in testing and accountability provisions and explores some of the early results of those changes. Section 3 discusses systemic reform of instructional guidance both in this country and abroad.

Four chapters draw directly from research conducted by CPRE:*

"Graduation vs. Education:
Reform Effect for
At-Risk Youth,"
Janice H. Patterson

"Educational Policy in a
Situation of Uncertainty;
Or, How to Put Eggs
in Different Baskets"
William H. Clune

"Systemic School Reform"
Marshall S. Smith
and Jennifer O'Day

"Reforming the Curriculum:
Will Empowerment Policies
Replace Control?"
Andrew C. Porter,
Doug A. Archbald, and
Alexander K. Tyree, Jr.

The Politics of Curriculum and Testing:
The 1990 Yearbook of the Politics
of Education Association
Edited by Susan H. Fuhrman
and Betty Malen

1991, 288 pp., hardcover $55 – softcover $25.50

Available from: E. Streisand, Falmer Press, 1900
Frost Road, Suite 101, Bristol, PA 19007-1598;
phone, (215) 785-5800.

* Reprints of these four chapters are available directly from CPRE. Send $4.50 for each title ordered to: CPRE, Eagleton Institute of Politics, Rutgers University, New Brunswick, NJ 08901.

Governance at the School-District Level

The main responsibility of the local district would be to provide resources and a supportive environment for the schools. Districts should examine aspects of their operations, including central bureaucracies and rules intended to standardize practice, that might inhibit innovative and effective school-based instructional approaches. Districts must also assure equitable distribution and use of common and base budget resources across schools, and administer special program resources in ways that maximize opportunities for needy children.

Districts may also deem it appropriate to establish their own long- range goals for improvements in student achievement and other areas that embellish the state goals— progressive districts might add such things as student participation and local service goals. Such long-term directions should guide board and superintendent activities, enabling them to eschew short-term "projects" and disruption in favor of steady nourishment to schools. One example of this might be a two- or three-year budget. Unions could assist by avoiding or waiving contract provisions which require standardized practice and inhibit the flexibility schools need to maximize achievement on the content goals.

These changes imply changing district operations so they focus on providing support to schools to reach the content goals. Central bureaucracies would shift from enforcement of requirements about practice to activities designed to assist schools improve instruction. Such a change would be greatly facilitated by a reform of state policy away from separate projects, each accompanied by a set of regulations and requiring a discrete administrative structure at the district level, toward coherent instructional guidance.

Conclusion

The strategy outlined by Smith and O'Day calls for combining systemic state-initiated reform and school-based reform (restructuring) to create something with considerably more chance of succeeding than either type of reform carried out independently. The structure provided by coherent state leadership could enhance the potential of school-based strategies.

For example, under various approaches to parental choice, the state curriculum frameworks would establish a protective structure that would help ensure that all schools were attempting to provide a challenging and progressive curriculum. Similarly, state examinations based on the curriculum frameworks would provide valid data about student outcomes to help parents and students make choices.

Schools could vary considerably on specific curricula, instructional strategies, extracurricular activities and other factors on which choices could be based.

Implementing a systemic reform strategy would require leadership and long-term perspectives on the part of policymakers as well as the support and involvement of professionals who would participate in developing the state instructional guidance system and take responsibility for high-quality programming at the school level. All participants, as well as the public, would understand that such an effort is not another "wave" of reform, another short-term strategy. In essence, Smith and O'Day have proposed a strategy for combining the "waves" of reform into a long-term improvement effort, a strategy for putting coherence and direction into the state reforms and content into the restructuring movement. ■

BEST COPY AVAILABLE

Bibliography

American Association for the Advancement of Science. 1989. *Science for All Americans*. Washington, DC: Author.

American Association of Colleges for Teacher Education. 1986. *Teacher Education in the States: A 50-State Survey of Legislative and Administrative Actions*. Washington, DC: Author.

Carnegie Forum on Education and the Economy. 1986. *A Nation Prepared: Teachers for the 21st Century*. New York: Carnegie Corporation.

Clune, William H. 1991. "Educational Policy in a Situation of uncertainty: Or, How to Put Eggs in Different Baskets." In *The Politics of Curriculum and Testing*, edited by Susan H. Fuhrman and Betty Malen. Philadelphia: Falmer. Forthcoming.

Cohen, David K. 1989. "Teaching Practice: Plus Ca Change...." In *Contributing to Educational Change: Perspectives on Research and Practice*, edited by Philip W. Jackson, 27-84. Berkeley, CA: McCutchan.

Cohen, David K. 1990. "The Classroom Impact of State and Federal Education Policy." Unpublished manuscript. School of Education, Michigan State University.

Coley, Richard J., and Margaret E. Goertz. 1990. *Educational Standards in the 50 States: 1990*. Princeton, NJ: Educational Testing Service.

Cuban, Larry. 1990. "Reforming Again, Again, and Again." *Educational Researcher* 19:3-13.

Darling-Hammond, Linda, and Barnett Berry. 1988. *The Evolution of Teacher Policy*. Prepared for the Center for Policy Research in Education. Santa Monica, CA: RAND Corporation.

David, Jane, Michael Cohen, Dean Honetschlager, and Susan Traiman. 1990. *State Actions to Restructure Schools: First Steps*. Washington, DC: National Governors' Association.

Education Commission of the States. 1990. "Transforming the Education System: Obstacles to Overcome." Working document. Denver, CO: Author.

Elmore, Richard F., and Associates. 1990. *Restructuring Schools: The Next Generation of Educational Reform*. San Francisco: Jossey-Bass.

Firestone, William A., Susan H. Fuhrman, and Michael W. Kirst. 1989. *The Progress of Reform: An Appraisal of State Education Initiatives*. New Brunswick, NJ: Rutgers University, Center for Policy Research in Education.

Fuhrman, Susan H., and Richard F. Elmore. 1990. "Understanding Local Control in the Wake of State Education Reform." *Educational Evaluation and Policy Analysis* 12 (No. 1): 82-96.

Fuhrman, Susan H., and Betty Malen (Eds.). 1991. *The Politics of Curriculum and Testing*. Philadelphia: Falmer. Forthcoming.

Guskey, T. 1986. "Staff Development and the Process of Teacher Change." *Educational Researcher* 15:5-12.

Little, J. W., W. H. Gerritz, D. S. Stern, J. W. Guthrie, M. W. Kirst, and D. D. March. 1987. "Staff Development in California." San Francisco: Far West Laboratory for Educational Research and Development; and Berkeley, CA: Policy Analysis for California Education.

McLaughlin, Milbrey W. 1990. "Enabling Professional Development: What Have We Learned." In *Staff Development and School Change: New Demands, New Realities, New Perspectives*, edited by Ann Lieberman and Lynn Miller. New York: Teachers College Press.

McNeil, Linda. 1986. *Contradictions of Control*. New York: Rutledge & Kegan Paul.

Mullis, Ina V. S., and Lynn B. Jenkins. 1990. *The Reading Report Card 1971-1978*. Princeton, NJ: Educational Testing Service, National Assessment of Educational Progress.

National Council of Teachers of Mathematics. 1989. *Curriculum and Evaluation Standards for School Mathematics*. Reston, VA: Author.

Newmann, Fred. 1988. "Can Depth Replace Coverage in the High School Curriculum." *Phi Delta Kappan* 69 (No. 5): 345-48.

Peterson, Penelope, L. 1987. "Teaching for Higher Order Thinking in Mathematics: The Challenge for the Next Decade." In *Effective Mathematics Teaching*, edited by D. A. Grouws and T. J. Cooney. Reston, VA: National Council of Teachers of Mathematics.

Purkey, Stewart, and Marshall S. Smith. 1983. "Effective Schools: A Review." *Elementary School Journal* 83 (No. 4): 427-52.

Purkey, Stewart, and Marshall S. Smith. 1985. "School Reform: The District Policy Implications of the Effective Schools Literature." *Elementary School Journal* 83 (No. 3): 353-89.

Resnick, Lauren B. 1988. *Education and Learning to Think*. Washington, DC. National Academy Press.

Smith, Marshall S., and Jennifer O'Day. 1988. "Teaching Policy and Research on Teaching." Stanford, CA: CERAS, School of Education, Stanford University.

Smith, Marshall S., and Jennifer O'Day. 1991. "Educational Equality: 1966 and Now." In *Spheres of Justice in Education*, edited by Debra A. Verstegen and James Gordon Ward. New York: Harper Collins.

Smith, Marshall S., Jennifer O'Day, and David K. Cohen. 1990. "National Curriculum American Style: What Might it Look Like?" *American Educator* 14 (No. 4): 10-17, 40-47.

Sykes, Gary. 1990. "Fostering Teacher Professionalism in Schools." In *Restructuring Schools: The Next Generation of Educational Reform*, edited by Richard F. Elmore and Associates, 59-96. San Francisco: Jossey-Bass.

Tyson-Bernstein, Harriet. 1988. "The Academy's Contribution to the Impoverishment of America's Textbooks." *Phi Delta Kappan* 70 (No.3): 193-98.

Reprinted with permission of Inverness Research Associates from "Science Education for the 1990s: Reflections on a 1991 Wingspread Conference" by Mark St. John. (c) 1992, 37-51.

STRATEGIES FOR CHANGE: ALTERNATIVE CONCEPTIONS

The Challenge for a Systemic Approach

At this time it is honest to say that neither funders, change agents, or mainstream educators knows how to bring about systemic changes that result in deep and long-term change in K-12 science education. We need greater wisdom and new insights into the ways that we invest in change, the ways that we conceptualize the "projects" we fund, and even the ways that we structure our relationships with each other. We are deeply immersed in a project-centered way of thinking, and the educational community may find, like the international development community, that our rhetoric changes while our practice does not.

> *Also, we are scared silly that we will have a systemic change approach that ends up freezing us into a bad model... but it must be also possible to build a bigger framework for systemic change that is loose enough to fit everything that we want to fit into it... There has to be a model that lets the kinds of good projects we now have to also fit in.*

At the risk of creating overly-simplistic dichotomies, we offer a summary (Figure 1) of some of the more important ways in which project-centered and systemic change strategies might differ. It is important to point out that systemic change approaches are not always superior to project approaches,[13] or that systemic change is now the next new "answer" to the educational crisis. Rather the chart on the following pages is probably more useful as a heuristic to encourage further thinking about change strategies -- thinking that will hopefully raise the clarity of all of our reform efforts.

---

[13] Some conference participants argued strongly that we should not abandon the funding of short-term projects, as they were very important in pushing the leading edge of educational curricula, teacher education, and contextual development. Moreover, they argued that "systemic reform," while theoretically appealing, was an unproven approach, laden with severe difficulties of its own.

FIGURE 1: PROJECT-BASED CHANGE VS. SYSTEMIC CHANGE

PROJECT-BASED CHANGE MODEL	SYSTEMIC CHANGE MODEL
Primary change agents are external to the system being changed	Primary change agents are key players in the system that is changing itself
Locus of control: control of the project ultimately resides in the hands of the external funders and experts	Locus of control: control of the systemic effort ultimately resides in the hands of those living and working within the system
Role of change agent: designer, leader, orchestrator, developer, outside expert	Role of change agent: facilitator, organizer, coordinator, technical assistant
Activities of (external) project members seen as central activity; grassroots participation as a means to achieve project's goals	Grassroots participation as central and ongoing process; project is seen as a means for enabling and supporting local processes
Deficit assumption: people need to be helped (motivation: charity)	Strength assumption: people can help themselves (motivation: shared self-interest)
Time perspective: short-term	Time perspective: long-term
Projects are temporary and develop alternatives; they operate parallel to mainstream practices	Systemic efforts are continuing and embedded in mainstream practices
Selective focus: projects deliberately ignore some dimensions and constraints	Comprehensive focus: systemic efforts address all relevant dimensions and constraints
Projects separate out and specialize in efforts to develop curriculum, provide professional development, or restructure schools	Systemic efforts seek integrated efforts to develop curriculum, provide professional development, and restructure schools
Project objectives: centered around project goals	Systemic effort objectives: establishment of community capacity to identify problems, access resources
Projects are inherently short-term and focus on one or two dimensions	Systemic efforts are inherently long-term efforts and focus on many key dimensions simultaneously
Projects operate within constraints of existing economics, structure, and governance	Systemic efforts address key constraints -- economic, regulatory, structural, and cultural
Projects use schools, teachers, and students to learn better how the model should work	Systemic efforts use researchers, university experts to learn better how the system might modify its own efforts to change

Funders fund projects based on the expertise of the external change agents	Funders fund efforts based on the capacity and commitment of the system
Funders seek dramatic local projects that have implications nationally	Funders seek national examples that might guide local action
Funders place high premium on: novelty, innovation, effectiveness	Funders place high premium on: collaboration, incremental value, capacity building, integration
Leverage: projects seek leverage by being "catalytic, or building models"	Leverage: systemic efforts seek leverage through long-term capacity building and fostering self-sufficiency
Schools are seen as field or test sites; they are used to "pilot" new ideas	School sites are seen as the primary actors and beneficiaries
Modes of communication: informational, training, education	Modes of communication: dialogue, conversations, inquiry
Underlying metaphors: engineering, product development, medicine, technology diffusion	Underlying metaphors: learning community, third world development, grassroots community organization, agricultural extension
Projects separate the research and development phase from the dissemination effort	Research and development happen in the local system simultaneously with "dissemination" (incorporation)
An "infusion" model: projects develop and illustrate improved products and practices which (hopefully) the system will recognize, adopt, and implement	Efforts provide assistance to systems as they re-engineer (and replace) their own products and practices
Projects seek to add products and practices to current repertoire (assumption: there is a vacuum waiting to be filled)	Efforts seek to have participants decide to gradually replace products and practices with more successful ones (assumption: there is already a full plate of existing practices and products)
Assumption: reform will happen when teachers comply with recommended procedures	Assumption: reform will happen when teachers have time, resources, and permission -- space to experiment and fail -- and achieve authentic ownership
Project aimed at specific changes; evaluation studies project "impacts"	Project aimed at development; evaluation studies capacity building of community
Project success judged by standards that focus on quality and extent of impacts, outcomes	Project success judged by standards that focus on quality of process, interactions

BEST COPY AVAILABLE

Evaluation, done by outside objective evaluator, yields proof of effectiveness, generalizable findings; prescription, recommendations for others	Evaluation, done by participating insider or outsider, contributes to the conversation; specific findings unlikely to be generalizable; recommendations aimed at system participants

Elements of New Change Strategies

To invest in science education reform effectively, we need to better understand the systems we are trying to change and we need more accurate ideas of how that system changes itself (or doesn't). While the conference was not successful in identifying the strategy to pursue, it did produce many good ideas about the general characteristics of effective reform efforts and investment strategies. In this section, we review and summarize the ideas that might underly new approaches to funding science education reform efforts. We pose these ideas not as complete in themselves, but rather as challenges that must be met by funders, change agents, and practitioners together.

Finding New Metaphors for Change

> *Where are there other good models? One we discussed... is the soil conservation example in the United States ... where you have agents in the field who exist in every location in the country, and whose job it is to be very highly trained in content and in how to do soil conservation education. They live out in the field -- they help districts -- they help them file for federal funds; they help steer programs. They are sort of resource people, and yet they are also proactive. They come together and meet constantly to find out what is happening in the whole soil conservation field. There is a lot of travel involved... so this ends up being a kind of infusion model at a local level... they can make a difference -- but only when you are dumping in other resources and other funding.*

As we have discussed in earlier sections, the metaphor that underlies our reform efforts is one that is based on infusion, persuasion, adoption, and dissemination. The change strategies of most science education projects, be they aimed at curriculum development, professional development, or even restructuring efforts, are embedded in this underlying project-centered metaphor. Perhaps other disciplines, other reform efforts, both current and historical, could offer the science education field some alternative approaches and metaphors for change.

In this paper we have explored some (rather striking) parallels between educational reform efforts and third world development programs. Other similar explorations outside the field of education might yield more lessons and insights to help us broaden our vision.

> *I am sort of curious about what is known about systemic change in general. Are there models that work in other fields? What do we know about how people try to change things about literacy or about health? We had some talk about international development... and yet it really struck me that we always tend to fall back and do project thinking – even when we are talking about systemic change. We are constantly doing that.*

Re-defining Relationships

We need to be able to re-define the relationships that currently structure most project-centered reform efforts. There is indeed a role for outside expertise and resources in assisting those working in the educational mainstream in their own development efforts.

And yet the relationship between those on the outside and the inside must be both honest and forthright, allowing for local communities to draw upon outside expertise, while at the same time empowering those local communities to take responsibility for and control over their own development.

This shift in relationships is perhaps the most difficult step in moving toward a systemic approach. It involves shifts in economic and political power, as well as changes in the locus of control. Teachers and others in the schools live in a culture that indeed has some of the characteristics of the "peasant subculture." They have a mindset congruent with a long history and tradition of non-empowerment. And yet this tendency toward inertia is not a good starting point for developing successful change efforts: effective approaches will have to find ways to work from practitioner strengths and interests, not from their weaknesses or deficits.

Sarason[14] similarly points out the need for a shift in what he calls "power relationships" as a *sine qua non* of systemic reform efforts:

---

[14] Sarason, p. 46.

> *I have emphasized that adopting a system stance is no easy matter, and, given our state of knowledge and experience, it does not now provide us with a course for action. But of one thing I am certain: any effort at reform has to have as its goal a change in existing power relationships in the system. That, I hasten to add, is no guarantee of success but it is a precondition for other alterations in the system... Changing a system is not for the conceptually and interpersonally fainthearted.*

While there is increasing belief in the funding and change agent community that a grassroots or bottom-up approach is needed, the external change agents share a reluctance to "let go." Again, there is a strong parallel with those working in third world development:

> *How could the scholars who had condemned the mass of peasants as traditional and lacking in motivations, aspirations, innovativeness, empathy, and a plethora of other factors constituting the subculture of peasantry, also suggest that these very peasants be in the vanguard of such bottom-up approaches? Such apparent contradictions and the lack of viable strategies for bringing about grassroots participation may be some of the reasons why top-down approaches still prevail in much of development.*[15]

Some researchers studying math teachers engaged in the reform efforts in California see the same dilemma for bottom-up reform efforts as are found in third world development efforts.

> *Teachers are at once the target and the agents of change... On the one hand, teachers are central actors in the old school subjects: they offer a mechanical version of reading or writing or mathematics and the result offends reformers... Teachers use of new materials is filtered through established practice... Often it bores students. Teachers are, in one sense then, the problem that policy seeks to correct. On the other hand, teachers are the most important agents for improving things: students' encounters with mathematics in school will not change unless teachers change them... But how can teachers teach a mathematics they never learned in ways they never experienced?*[16]

The challenge for those undertaking systemic change efforts will be to find ways to empower teachers (and many others involved in education) while at the same time acknowledging their realistic limits of knowledge, skills, and experience. Systemic efforts will need to provide wide ranges of integrated support to help local educators see and overcome existing limits. Such arrangements only come out of honest and appropriate relationships that transcend existing structural and professional definitions.

---

[15] Melkote, p. 135.

[16] Cohen David K. and Deborah Loewenberg Ball. *Policy and Practice: An Overview.* Educational Evaluation and Policy Analysis. Vol. 12, No. 3, Fall, 1990, p. 238.

Comprehensive, Multi-dimensional Efforts

Systemic Change Efforts: Some Implications for Funders

To the funders, I say you must fund infinitely more staff time. Communicating with large numbers of players on a regular basis is the most staff intensive effort known to the human race. It takes an army. But you must have funding mechanisms. Funders can't keep on thinking that they are funding part-time volunteers who really do something else for a living. Change is a professional business and it takes an enormous number of people. The dollar scale of what you have to invest in staff costs is enormously larger than what funders are used to. You look pretty bad when the evaluation comes back and says "What did that person do that we paid for?" "Oh, talked to a lot of people." There is a tremendous amount of that which is needed.

The second thing is to recognize in funding that the creativity is going to emerge more and more, not just in the scientific and the teaching component, but in the end, in the implementation. In the development of the plan's strategy, that is the place the greatest creativity is needed. That is not a place that one is used to thinking of being a creative component.

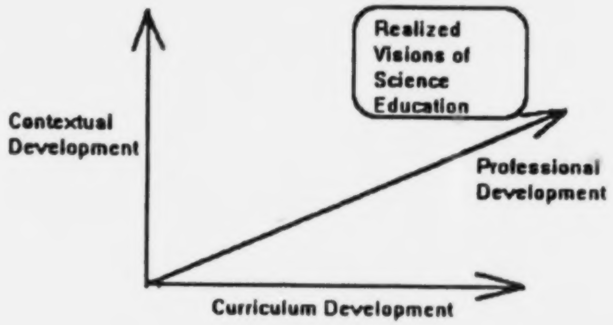
Many more funders need to think of not directly funding many things, but funding intermediate change agents. That is to say, that for most funding organizations, it is exceedingly difficult to maintain a staff that stays sufficiently on top of the whole national landscape in something to make all of the funding decisions. So you have to work with intermediate agents.

Most projects, to date, have addressed only one or two of the critical dimensions of the contexts in which they work, leaving the other dimensions, at worst, to

BEST COPY AVAILABLE

chance, and at best, to other reform efforts.[17] In fact, one characteristic of a project-centered approach is that it sees the characteristics of context as secondary to the characteristics of the design of the program. In fact, the opposite may be true. Close study and evaluation of most project efforts often tells more about the important factors of the context in which the program is happening than about the program itself.

Systemic efforts will need to address in a coherent and cohesive fashion all of the major dimensions that shape actual practices of education. Such efforts will simultaneously have to involve, at a minimum, cohesive efforts in curriculum reconceptualization, professional development, and contextual development.



Multi-Dimensional View of Systemic Initiatives

---

[17] At the conference, this limited focus was referred to as the "hope gap." At some point those working on projects are left at a point where they say, "I hope the curriculum gets disseminated," or "I hope the lead teachers will find ways to give workshops to their fellow teachers," or "I hope the university will institutionalize the program after the funding expires."

It is important to note where we are in the process of knowing how to address these dimensions simultaneously. Most of our experience has come from professional development and curriculum development projects. Only recently have we realized the need to integrate the two.[18] Now with "restructuring" efforts across the country we are faced with the challenge of integrating all three dimensions. This is clearly a much more complex proposition. In fact, it so complex that funders will not be able to support single projects that can in one fell swoop change science education in a state, district, or even school. Rather they will have to support efforts which are much more process-oriented, more iterative, less well-defined in the beginning, and involve a wider range of expertise from people both inside and outside the system.

Addressing Constraints

> *What do we really know about the constraints in the system? What are the things that are really stopping us? There are all kinds of things -- like time and space in the classroom -- and there are all kinds of issues that we can identify -- no one had a good experience in science at school; everyone is an expert because they went to school... All of these things... If we really examine these constraints, it seems that we might be able to get rid of a few of them and actually make a lot of progress.*

Following the lessons learned in international development efforts, we will clearly need to identify, and then address, both internal and external constraints. Systemic efforts can address very real external constraints by one, helping remove regulatory constraints to innovation, and two, providing a range of resources that will help to build some of the systemic capacity (infrastructure) noticeably absent in our educational systems. Funders will need courage to fund capacity-building efforts, which are both necessarily vague and long-term in nature, but which are also essential to deep-rooted systemic reform efforts. Clearly, this will require changes in the reward and incentive structures of the very foundations in which the funders find themselves working.

---

[18] Ironically, for years because of political and legal reasons, NSF avoided any integration of its curriculum and professional development projects, particularly making sure that professional development projects were not focused on any one single curriculum.

> *Systemic change requires not much, much more, but infinitely more focus on building infrastructure... but at the same time the focus must always be on the teacher and the student, and particularly what the teacher needs... You can never lose sight of that, no matter how systemic you think you are... You must understand everything in those terms. You will understand what is needed only if you go and stand where the classroom teacher stands and look out upon the world and ask yourself, "What help do I need?" Never forget that.*
>
> *If you think about it for just 15 minutes, most of the structures for delivering the help that teachers need are not there. Therefore, a major preoccupation of systemic change must be building the infrastructure necessary for delivering the support to the classroom teacher.*

We will also have to address internal constraints which reside in the culture of our schools, in the habits of mind of the practitioners, and the traditional thinking of the broader society. Such internal constraints are best addressed by a long-term educational effort, accompanied by a political effort to rally resources and power needed. The larger culture in which schooling takes place must be asked to shift its stereotypical views of schooling and learning. Because everyone has a personal history of schooling, it is very difficult to create alternative visions of what education might be. Public campaigns on the order of those conducted for smoking, or AIDS awareness, may well be needed. The point is that funders should not continue to fund one-dimensional programs that ignore the very real external and internal constraints that make a lie of their underlying change strategy

Building Alliances and Collaborations

Systemic change involves much more planning. It is planning involving many more people than the (project-centered) process one is accustomed to, and the planning involves really doing strategic planning, not just using last decade's piece of jargon.

And I think what we learned is not only much more -- but much, much more communication is needed between many, many more groups. There is always more time needed than you anticipate for communication. A great deal of it has to be face to face -- it is a rather large undertaking -- and it has to be communication in which everyone is a meaningful player.

Systemic efforts cannot be planned by any one person or group in advance; they must involve alliances, partnerships, and all key players and decision-makers. Ultimately, the collaborations and alliances will have to soften the distinctness of the identities of the collaborators, and boundaries will have to blur. Projects too often reinforce the professional identities of those involved, thus contributing to the fragmentation, which in some sense, is itself a core cause of the very same systemic problems being addressed.

Ongoing Education About Educational Change

We need infinitely more education about education for all the players. Education in the United States is... a cosmic system. It is immense. And everyone's intuition about such large systems, by and large, is terrible -- especially boards of foundations and many change agents themselves. Their image of how you would go about changing such a system and how you would measure progress is just atrocious. They apply single-minded models from areas that simply don't make any sense at all... So we need a constant process of educating people about what you can expect in the way of change and what kinds of time scales are involved...

You must educate hard-nosed thinkers in the political world and the business world about how complicated a process it is, and you must constantly educate educators in academia about the fact that they must go twice as fast as they are accustomed to going and not think of all the reasons that things cannot be done.

BEST COPY AVAILABLE

Too often, those in the funding and change agent community focus too much on the horizon they are walking toward. They worry at great length about their vision -- the way science education should be, and the ways in which it is lacking. More time should be spent understanding the system as it actually is now, and why it is the way it is. Then, much more time should be spent thinking about funding and reform strategies that reach into that system and change it, or help it change itself. It is not only funders and change agents who are naive and simplistic about change. In general, the practitioners working in the educational system are too close and have too little time to be insightful about the changing of their own culture and systems. The broader public is simply confused and frustrated by what they see as a huge system that appears to be both non-functional and non-changeable. Across the board all players need to pay attention to, learn about, and explore together the issue of change itself.

New Roles for Research and Evaluation

> *There must be a fundamental change in the way that education research and evaluation are perceived and conducted.. The era of the objective observer of education reform, standing off at a distance and evaluating what goes on is a completely passé notion. Evaluation, observation, and research has to be an integral part of and directly involved in the change process, because otherwise it means nothing.*

A project-centered approach assumes that the project is a "treatment" and the role of evaluation and research is to understand and prove the effectiveness of the treatment. Such a conceptualization for research leads to a goal-oriented specification of outcomes and quantitative/statistical assessment of progress. Just as systemic efforts require new metaphors for the change process, the roles of evaluation and research need parallel reconceptualizations.[19]

An Overarching Vision and Strategy

Finally, back to the starting point of this paper, new strategies for change will not help science education unless we can arrive at a shared vision of what science education should be.

---

[19] See, for example, these three volumes in the New Perspectives in Evaluation series: Metaphors for Evaluation, New Techniques for Evaluation, Communication Strategies in Evaluation. Ed. Nick L. Smith. Beverly Hills: Sage Publications, 1981.

It is hard to exaggerate the importance of all of the players working within a framework of a shared plan and overarching change strategy. Within such a framework, foundations and individual projects can find their own niche. It is more possible than one thinks to develop such a framework. There is also a growing mood in the whole education world today and there is much more willingness to talk about consensus today.

To be palatable to educators, a shared vision for science education will not only have to be grounded in philosophical tenets about the nature of learning, but it will also have to be viable in the context of all of the realities of today's schools. This vision will have to illuminate clearly the nature of traditional practice, concrete examples of "idealized" practice, and key transitional practices that can be used as stepping stones along the way. A shared vision must communicate a passion for inquiry, a love of science, and an affirmation of the importance of the reform endeavor.

To be viable in the educational community, a vision for science education must be abstract enough to allow "buy-in" on a national scale, leaving room for ongoing debate as to the exact ways that vision is to be manifested. Similarly, a vision must allow for involvement of local site ownership and further development, and not be seen as yet another "top-down" mandate.

Moreover, a vision for science education must include the idea of its own long-term achievement. Reform must be presented not as a process of implementation or dissemination but rather one of long-term development, growth, and change.

Elmore and McLaughlin describe well the need to reconceptualize the vision of the reform process:

> *In brief, our argument is that reform of the basic conditions of teaching and learning in schools requires "steady work" of a different sort than has characterized educational reforms of the past. In some sense, these reforms must originate in the practice of teaching rather than in expert advice and external standards as have past reforms.*[20]

It is also critically important that a shared vision of reform address directly the need to create learning opportunities where every student has an a priori chance to succeed in science (and, indeed, in education more broadly). Groups traditionally underrepresented in science and in successful science education include minorities, women, students with limited English proficiency, and economically disadvantaged students. A vision of science education must directly point out the ways in which these students will have new opportunities for successful experiences.

---

[20] Elmore and McLaughlin, p. 4.

The shared vision we create must also be comprehensible and appealing to a broader community, which, in turn, means that we also will have to transform our visions of educational change into larger political terms and social issues. Few Americans will lose sleep over the fact that their children are not engaged in hands-on science. On the other hand, if they come to understand that their children are receiving an education whose very nature fails to empower them to succeed as individuals, there is a more compelling argument for educational reform.

Asserting the Achievement

One idea about systemic change is more down to earth and practical, but it is the hardest idea for many educators and academics... It means we have to learn about "marketing." I never thought that I would see the day that I would be in the marketing business, learning to construct simple metaphors for everything that you want to tell people... Try to think of a metaphor... a one liner...

Systemic change also means practicing politics, and there are people in this room who practice it a lot. First you have to develop the attitude that politics is not a bad thing -- it is the process by which people come together to decide on common courses of action... And you have to be a part of that. You have to practice it if you are a systemic change agent. You have to practice the politics of inclusion all the time... you have to include all of the constituencies in everything, but more than that, you have to learn that politics is a game of skill, not a game of chance. If you don't develop the skill for it, you are going to get pretty beat up by the political process.

Finally, achieving systemic reform requires a certainty and optimism that a careful analytical analysis of the situation would not warrant. One simply needs to assert not only that consensus about a shared vision is indeed a possibility, but rather that it already exists. Similarly, one needs to address all the players involved in systemic change with the underlying assumption that success is assured. Such positivity is not merely whistling in the dark, but rather it forms a crucial part of the foundation for successful systemic change efforts.

You have to accentuate the positive if you want to do systemic change. Eliminate the negative. Years ago I spoke with one woman who was involved in a math reform effort; she said one of the most important components of her job was faith. Because if you don't believe that you can actually change the system, you won't. And we don't usually use words like "faith" but it is a terribly important thing. You have to believe that you can move the system and you have to use your positivity as an infectious quality. It spreads to a lot of other people... and then you just keep pushing down that road.

Reprinted with permission
of the American Association
of School Administrators.
(c) 1991, 8-13.

Recapturing the Spirit of Learning Through a Systems Approach

BY PETER SENGE and COLLEEN LANNON-KIM

Mark, a substitute drama teacher at the Orange Grove Middle School in Tucson, Ariz., is struggling with his eighth-grade class. The regular teacher left the students a difficult assignment that involves forming small groups and presenting a dramatic reading.

But the students have a two-day field trip planned next week to see firsthand how the court system works and to prepare for a mock trial. Mark worries that since the groups will have just begun meeting on the first project when the trip starts, the momentum of the project will be broken and the students will have to start over.

Mark brings his problem before the weekly eighth-grade team meeting. Together, the teachers discuss his concerns and consider whether the field trip should be postponed. The team leader asks the government teacher, who has organized the trip, whether she still plans to require the students to write a "screenplay" of the dialogue for their trials beforehand.

"Since they are studying character development and conflict in literature class," he offers, "it might make sense to have that be their literature assignment, and then have them act it out for the drama class instead of doing the group project."

The other teachers accept the idea enthusiastically. Mark believes the

716

BEST COPY AVAILABLE

court cases will make great drama presentations, and the government teacher says the students will be more engaged in the court case if they spend some time actually "living" the role of a judge or an attorney.

"In a normal school situation, that substitute would have been stuck in that classroom for a week and a half with a disaster on his hands," comments the team leader after the meeting. "Those kids would have been going nuts in there. And the rest of us would have seen it in our classroom but we wouldn't have had any idea what was wrong. The problem wasn't just Mark's—it was a system-wide problem that we all had to deal with."

A Learning Organization

Team meetings like this are an example of what the staff at Orange Grove calls a "systems approach" to education. "Our goal is to increase the effectiveness and efficiency of our total system," explains Principal Mary Scheetz. "In order to do so, we need to break that total system into manageable subsystems with common focuses or purposes, like teams for each grade. Group events help maintain an understanding of the relationship of the parts to the whole and address common concerns."

Orange Grove is one of a small number of schools nationwide leading a movement to transform schools into "learning organizations." Says Scheetz: "Systems thinking is our conceptual cornerstone, but it is really the combination of systems thinking and the related disciplines of building shared vision, working with mental models, team learning, and personal mastery that hold it together."

"Without a shared vision," she explains, "people have no idea of what they are trying to accomplish by improving the system as a whole. And they will make little progress if they do not know how to reflect on their own assumptions, especially within their work teams.

"Personal mastery for us is a sort of anchor. When all is said and done, the school must create an environment where everyone—students, teachers, staff—has the opportunity to continually enhance their capacity to create results that really matter to them, that is *to learn*."

Systems thinking is a discipline for seeing wholes, recognizing patterns and interrelationships, and learning how to structure them in more efficient ways.

With prescriptions for turning around America's schools coming from every part of the political spectrum, re-conceiving schools as learning organizations may be the overarching vision needed to guide the difficult changes ahead.

"How can we expect kids to become committed to learning if the overall environment isn't committed to learning?" asks Jim Daniel, president of the Kentucky Educational Foundation, which is playing a significant role in reforming the state's K-12 educational system. "The problem has been that forces throughout the educational system have worked to make protecting special interests more important than continually improving the system as a whole."

Turning schools into learning orga-

BEST COPY AVAILABLE

Applying the Systems Approach in the Classroom

The five learning disciplines are for facilitating learning within classrooms.

At Orange Grove Middle School in Tucson, Ariz., the systems approach also is used as a conceptual framework and methodology for enhancing students' understanding of subjects. In classes, systems thinking gives cohesion to disparate facts. Inert subjects come alive through the use of computer simulations, as students test out their own ideas of how elements interact in a complex system.

In a project called "New State Park," Orange Grove students researched park philosophy and management, land management, recreation theory, social systems, geography, ecological community theory, and politics.

"They then used their newly acquired knowledge to design a new park with a $100 million budget," explains teacher Frank Draper. "The park had to include land required by the park's charter, yet deal effectively with a threatened lawsuit if they desecrated nearby Indian burial sites; be attractive to users, yet not cause appreciable environmental degradation."

As the students designed the park on the computer, Draper says, they used a spreadsheet to keep fiscal accountability and a simulation model of park development and environmental degradation to keep design accountability.

Not only does this integrated approach engage students' interest, it accelerates learning. Through projects such as the New State Park, students not only cover traditional material, but they gain additional understanding of the subject because of the integrative format.

Pamela Hopkins, an English teacher at Desert View High School

We've all been taught since an early age to focus on symptoms rather than underlying causes.

nizations will require some fundamental changes in the way they are run. The challenge is to extend learning to all levels of the school—not just in the classroom, but among teachers, administrators, and all staff.

We cannot expect teachers to create effective learning environments in their classrooms if they aren't being supported and engaged in learning themselves. This simple fact has eluded most educational reform efforts, which have treated innovation in the classroom as being synonymous with innovation in education.

To achieve real improvement, leaders must be prepared to assume new roles and master new skills. The task is enormous, but so are the potential payoffs: better-educated students who are able to synthesize disparate facts into a cohesive framework for solving problems; empowered educators who have the guidance and support they need to put innovative ideas into practice; and overall, an educational system that is continually improving itself.

Five Disciplines

The key to transforming schools into learning organizations lies in understanding the individual and collective capabilities needed to build such institutions.

Traditional authoritarian organizations are dominated by internal politics, game-playing, fear, and self-protection. This behavior comes from deeply-rooted habits of thinking and interacting. We have all been taught since an early age to break problems apart, to focus on symptoms rather than underlying causes.

We have learned to avoid making mistakes at all costs, which has replaced our natural curiosity and love of experimentation with a desire to provide "the right answer" and to look good. We are easily threatened in a group, fearing that we might reveal our ignorance or incompetence.

To create fundamental change in our schools, we must learn new ways of thinking and interacting that emphasize continual learning and understanding the larger systems in which we live and work rather than protecting our "turf." This is the significance of the five *learning disciplines*—systematic approaches to developing such ways of thinking and interacting.

Systems thinking is a discipline for seeing wholes, recognizing patterns and interrelationships, and learning how to structure those interrelationships in more effective, efficient ways.

"The buzzword for our activities is 'restructuring,'" says Peter Holland, the superintendent of Belmont, in Tucson, used a simulation model with her class to analyze the motivation of Shakespeare's Hamlet to avenge his father's death. In a group setting, the students examined act by act the plot of Hamlet to determine what impact each event would have on Hamlet's desire to kill Claudius. The computer then simulated the outcome of their choices.

"It was as though the use of precise numbers to talk about psychological motives and human responses had given the students power—a real system they could communicate with," says Hopkins. "It turned thin air into solid ground."

The simulation also had a dramatic effect on the learning process. "For the first time in the semester, I was not the focal point of the class," Hopkins recalls. "I did not have to filter the information from one student back to the rest of the class. They were directed and in control of the learning, instead of my having to force them to keep their attention on the task."

Other schools around the country also have used a system thinking approach to enrich specific content areas. In the Brattleboro, Vt., High School, history students developed a systems thinking framework for understanding the social forces that led up to the American Revolution. They then studied other revolutions—both historical and current—to explore how their theory "fit" the various settings.

In the Hillview Middle School in Menlo Park, Calif., the science, math, and literature teachers have been working together for the past two years on a multi-disciplinary approach to their subjects by collectively teaching nine-week units organized around a common topic.

Other schools following a systems approach are Cambridge Rindge and Latin, Cambridge, Mass.; Thomas Jefferson High School for Science and Technology, Alexandria, Va.; and the Ridgewood Public Schools, Ridgewood, N.J.

—Peter Senge and Colleen Lannon-Kim

Mass., schools and part of a group of superintendents exploring ways of bringing systems thinking to bear on issues of school administration. "We are looking at how to change the system to provide students with better learning environments at a lower cost."

Adds Scheetz: "Through a systems thinking approach, our staff members have become increasingly cognizant of the need to develop an integrated curriculum. We also now have a greater awareness of the importance and power of collaborative decision-making. Both instructional and organizational designs are focused on having the big picture, understanding systems phenomena, and considering potential effects of decision-making and related actions."

Building shared vision is about groups learning to articulate compelling images of what they truly want to create. "Unless leaders know how to assist in shaping the new vision for the individuals and the organization as a whole, these new ideas will never get into the classroom," warns Daniel.

Building shared vision is a continual process—one never "arrives" at a shared vision. It is not an endpoint but a beginning, because it is the source for all activities that flow out of that vision. As one Orange Grove teacher described it, "I see us continually growing, interacting, and changing ... not a product, but a process."

Personal mastery—the discipline of personal growth and learning—is the spiritual foundation of the learning organization. Fundamentally, personal mastery is about creating what we want in our own lives. Without individual visions there can be no shared vision, which is why a commitment to each individual's personal growth is so important in a learning organization.

As Scheetz explains, "We are allowing our shared vision to evolve through activities that help us share our personal vision with each other. In a recent workshop we had people describe their personal visions, share those visions with others, and then work on achieving a consensus about a shared vision and representing that vision in whatever way they chose. The result was a number of extremely creative and entertaining presentations, which motivated a lot of follow-up dialogue about what is really important to all of us."

Putting individual and collective visions into practice requires new skills for gaining an accurate picture of current reality. No one carries a school system, political system, or community in his or her head. What we carry in our head are assumptions—internal pictures that we continually use to interpret and make sense out of the world. These "mental models" influence how we perceive problems and opportunities, identify courses of action, and make choices.

The discipline of *working with mental models* requires the ability to distinguish what we have actually observed from our assumptions and generalizations based on those observations and the willingness to hold our assumptions up to scrutiny.

In a team setting, working with mental models dictates new ways of interacting. Most teachers are skilled at articulating their views and presenting them persuasively. While advocacy skills are important, they become counterproductive when we confront complex issues that require collaborative learning among different, equally knowledgeable people.

Much of the early work at Orange Grove involved developing team learning skills—balancing inquiry and advocacy to achieve collaborative decision-making.

"Because educators are likely to continue old habits even in a new structure, developing and continually reinforcing new habits is necessary."

says Scheetz. "The most effective way to do this is by developing team learning skills within the same groups who have to work together."

Rethinking Leadership

Like artistic or spiritual disciplines, the learning disciplines only have power when people are committed to their practice. This commitment is the essence of leadership.

"I talk with people all over the country about learning organizations, and the response is always very positive," says William O'Brien, chief executive officer of the Hanover Insurance Co. in Worcester, Mass.

"If this type of organization is so widely preferred, why don't people create such organizations? I think the answer is leadership. People have no real comprehension of the type of commitment it requires to build such an organization."

Creating a learning organization will require a fundamental rethinking of our concept of leadership. Our traditional view of leaders—as special people who set the direction, make key decisions, and energize the troops—is deeply rooted in an individualistic and nonsystemic world view. According to this viewpoint, leaders are "heroes"—great men and women who rise to the fore in times of crisis. Such myths reinforce a focus on short-term events and reacting to crisis rather than on systemic forces and collective learning.

We believe a new view of leadership is emerging—one where leaders are responsible for building organizations where people are continually expanding their capabilities to shape their future. In a learning organization, leaders' roles will differ dramatically from that of the charismatic decision-maker. They will be designers, teachers, and stewards.

These roles require new skills derived from the learning disciplines: the ability to build shared vision, to bring to the surface and challenge prevailing mental models, and to foster more systemic patterns of thinking.

Leader as Designer

Imagine your school or school system is an ocean liner and you are the "leader." What is your role?

Many people would respond "the captain," others perhaps "the navigator, setting the direction," or the "engineer stoking the fire, providing energy," or "the social director, making sure everyone is involved and communicating." While these are all legitimate leadership roles, there is another which, in many ways, eclipses them in importance—the designer of the ship.

No one has a more sweeping influence on the ship than the designer. What good does it do for the captain to say, "Turn starboard 30 degrees," when the designer has built a rudder that will only turn to port, or which takes six hours to turn to starboard? It's fruitless to be the leader in an organization that is poorly designed.

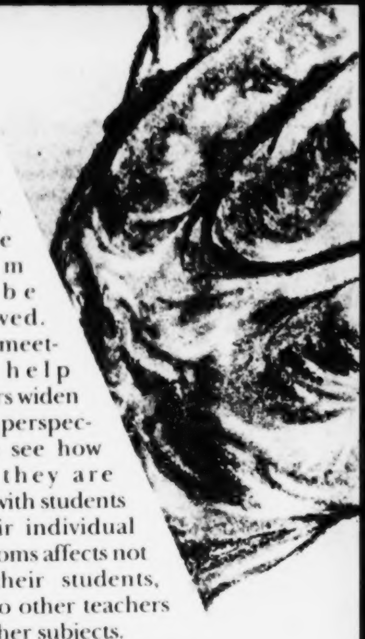
The first task of organizational design is to articulate the ideas of purpose, vision, and core values by which people will live. The second is to create the policies, strategies, and structures that will translate those guiding ideas into practice.

This requires creating effective learning processes. Leaders are not only responsible for ensuring that an organization has well-developed strategies and policies, but also for ensuring that processes exist whereby they are continually re-examined and improved.

"The concept of leader as designer is paramount in our school," says Scheetz, Orange Grove's principal. "My assistant and I find ourselves designing not only the schedule but the organizational format and learning opportunities, including what groups of people will be aligned together, how often they will meet, and for what purpose."

For example, to promote a more integrated curriculum at Orange Grove, classes are scheduled in blocks so that meeting times can be shortened, lengthened, or combined to allow students to pursue more in-depth projects, such as the "New State Park" project at Orange Grove (see story, page 10). Teachers for each grade also share the same planning period each day, so they can plan inter-disciplinary projects together.

At an organizational level, teachers are organized into teams by class or by function (e.g., eight-grade team, support team, electives team) that meet regularly to solve problems or discuss ways in which the whole system can be improved. These meetings help teachers widen their perspective to see how what they are doing with students in their individual classrooms affects not only their students, but also other teachers and other subjects.



As one Orange Grove teacher commented, "I have a new awareness that everything I do or decide to do affects others." Another observed, "I have undergone a general change in focus from what I am doing with my kids to what is happening for the kids."

Leader as Teacher

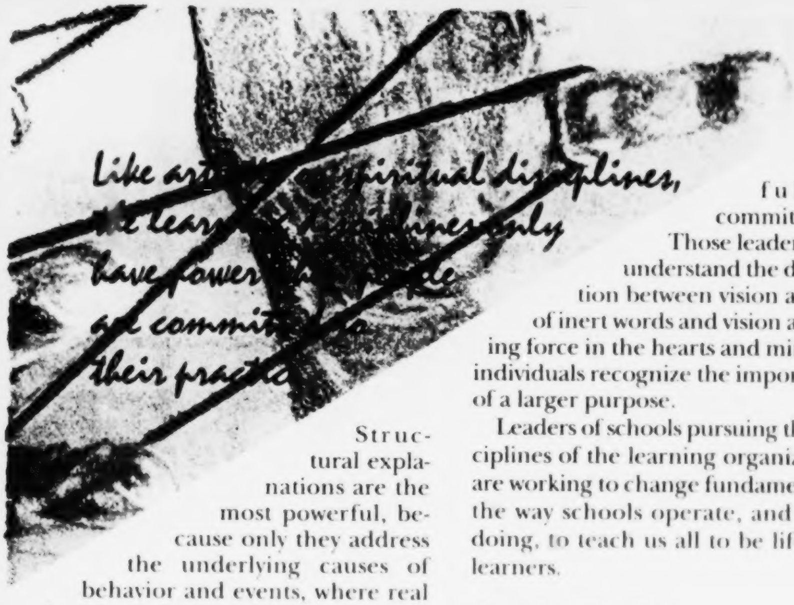
The role of leader as teacher starts with bringing to the surface people's mental models of important issues. The goal is to help everyone in the organization, oneself included, to gain more insightful views of current reality. This approach is similar to learner-directed learning, with the leader taking the role of a coach, guide, or facilitator.

Leaders as teachers also help people restructure their views of reality to see beyond the superficial conditions and events into the underlying causes of problems, and therefore to see new possibilities for shaping the future.

Specifically, leaders can influence people to view reality at three distinct levels: events, patterns of behavior, and systemic structure. All three levels of explanation are equally true, but their usefulness is quite different.

Event explanations—who did what to whom—doom their holders to continually reacting to change.

Pattern-of-behavior explanations focus on identifying long-term trends and assessing their implications. They at least suggest how, over time, we can respond or adapt to shifting conditions.


Like art… spiritual disciplines,
the lear… lines only
have power…
are commit…
their practic…

Structural explanations are the most powerful, because only they address the underlying causes of behavior and events, where real leverage lies for creating fundamental, long-lasting change.

Most leaders of current institutions focus their attention on events and patterns of behavior, and, under their influence, their organizations do likewise. Leaders of learning organizations must pay attention to all three levels, but focus especially on systemic structure. By example, they will teach people throughout the organization to do likewise.

Leader as Steward

Stewardship is perhaps the most subtle role of leadership. Unlike the roles of designer and teacher, the role of steward is almost solely a matter of attitude, but it is critical to learning organizations. Leaders' sense of stewardship operates on two levels: stewardship for the people they lead and stewardship for the larger purpose or mission that underlines the enterprise.

Stewardship for people arises from a keen appreciation of the impact one's leadership can have on others. People can suffer economically, emotionally, and spiritually under inept leadership. If anything, people in a learning organization are more vulnerable because of their commitment and sense of shared ownership. Appreciating this obligation naturally instills a sense of responsibility in leaders.

The second type of stewardship arises from a leader's sense of personal purpose and commitment to the organization's larger mission. People's natural impulse to learn is unleashed when they are engaged in an endeavor they consider worthy of their fullest commitment. Those leaders who understand the distinction between vision as a set of inert words and vision as a living force in the hearts and minds of individuals recognize the importance of a larger purpose.

Leaders of schools pursuing the disciplines of the learning organization are working to change fundamentally the way schools operate, and in so doing, to teach us all to be lifelong learners.

Creative Tension

The overarching principle for leadership in a learning organization is harnessing the power of creative tension. Creative tension comes from seeing clearly where we want to be—our "vision"—and recognizing where we are now—our "current reality." The gap between the two generates a natural tension.

Creative tension can be resolved in two ways: by raising our current reality toward the vision, or by lowering the vision toward current reality. Individuals, groups, and organizations who learn how to work with creative tension learn how to use the energy it generates to move reality more reliably toward their visions.

Without vision there is no creative tension. Creative tension simply cannot be generated from current reality alone. Many leaders believe if only people understood current reality they would surely feel the motivation to change. They are then disappointed to discover people resist the personal and organizational changes that must be made to alter reality.

What they never grasp is that the natural energy for changing reality comes from holding a picture of what *might be* that is more important to people than what *is*.

But creative tension cannot be generated from vision alone. It demands an accurate picture of current reality. Self-delusion, "white-washing," or otherwise protecting ourselves or others from seeing reality accurately, diminishes creative tension just as much as compromising our vision does.

As Robert Fritz, founder of DMA, a personal self-help organization in Williamsville, Vt., and author of *The Path of Least Resistance*, has observed, vision without an understanding of current reality more likely will foster cynicism than creativity—a scenario that is all too real for teachers frustrated with countless efforts to improve classroom teaching without transforming the overall school environment.

The principle of creative tension teaches us that an accurate picture of current reality is just as important as a compelling picture of a desired future.

Leading through creative tension is different from problem-solving. In problem-solving, the energy for change comes from attempting to get away from an aspect of current reality that is undesirable. With creative tension, the energy for change comes from juxtaposing the vision with current reality.

Many people and organizations find themselves motivated to change only when their problems are bad enough to cause them to change. This works for a while, but the change process runs out of steam as soon as the problems driving the change become less pressing.

With problem-solving, the motivation for change is extrinsic; with creative tension, the motivation is intrinsic.

"People are born with intrinsic motivation, self-esteem, dignity, curiosity to learn, and joy in learning," writes W. Edwards Deming.

The power of the learning organization resides in its ability to engage that basic human drive to learn. For leaders of learning organizations, the challenge is to turn that collective energy into a shared vision that is compelling for all members of the organization. Once that synergy is achieved, continually improving the system will become a natural extension of everyday activity.

Peter Senge is director of the Organizational Learning Center at Massachusetts Institute of Technology and author of The Fifth Discipline: The Art and Practice of the Learning Organization. *Colleen Lannon-Kim is editor of The Systems Thinker, a newsletter that applies systems thinking to organizational issues.*

Reprinted with permission of the Association for
Supervision and Curriculum Development from
Challenges and Achievements of American Educatio
(c) 1993, 116-133.

5

Innovation, Reform, and Restructuring Strategies

Michael Fullan

The history of the large-scale focus on educational innovation and reform is remarkably short. Although ideas about progressive education and the need for improvement in schools in the United States have been debated and tried since the turn of the century, only in the post-Sputnik era has the push for reform taken on national proportions. Thus, the intensive study of change has essentially occurred only in the last half of the 20th century. Those of us working in this period are privileged to have literally grown up with the field.

Our wisdom about change processes has become increasingly sophisticated; our focus for reform has become more comprehensive and deeper. Simultaneously, the problems appear more formidable and intractable. In this chapter, I trace this evolution of sophistication in change—concentrating on how far we have come, what lessons we have learned, and what we are facing for the future.

Evolution of the Study and Practice of Change

The terms *innovation*, *reform*, and *restructuring* are used loosely and inconsistently in the literature. Of the three, innovation is less sweeping, usually confined to specific single changes, such as a new curriculum, an instructional strategy, a new technology, or a particular organizational change like flexible scheduling or team teaching. Innovations are discrete, usually affecting only a particular aspect of schooling.

Reform and restructuring refer to more fundamental and potentially sweeping changes. Both terms are vague until linked to particular initiatives (and even then tend to be less than clear). Thus, governments engage in major "reforms," such as the Kentucky Education Reform Act of 1990 or Great Britain's Education Reform Act of 1989. But the term is also used more generally, for example, to refer to the need to reform teacher education. Restructuring has taken on a particular focus (but still vague) in recent years. It takes many forms, but usually involves school-based management; enhanced roles for teachers in instruction and decision making; restructured programs and timetables, collaborative work cultures, and new designs for teaching-learning; new roles such as mentors, coaches, and other teacher leadership arrangements (see Murphy 1992). People also talk about "restructuring" entire systems at all levels.

In this chapter, I consider four distinct themes of change over the past four decades, each of which implies a different focus and is associated with different assumptions and strategies. The four themes can be seen approximately in terms of each decade since 1960, although the exact transition points often overlap and are somewhat blurred:

1960s—Adoption of Reforms
1970s—Implementation Problems
1980s—Multiple Innovations
1990s—Systemic Reform

The first three themes set the stage for what we know and face for the future. The fourth theme, Systemic Reform, reflects the complexity and comprehensiveness of changes we face in the last decade of the 20th century. In the next sections, I describe each theme briefly, noting its contributions and its limitations.

Adoption of Reforms

The adoption era of the 1960s was generated by a national concern that U.S. education was falling behind scientific accomplishments in Russia. National (federal) leadership and resources were needed to "kick start" a rolling curriculum reform across the country. Federal coffers were opened for major curriculum reforms (PSSC Physics, Chem Study, Chemistry, New Math), technology innovations (television instruction, teaching machines), and organizational innovations (open schools, flexible scheduling, and team teaching).

At the same time, the civil rights movement in the 1960s pinpointed scores of inequities. These simultaneous concerns—academic excellence and equity for the socially and ethnically disadvantaged—drove federal strategies for improving education. A dramatic presence and influx of federal funds was signaled by the passage of the Elementary and Secondary Education Act of 1965, which channeled resources to the disadvantaged, to desegregation, and to the development and dissemination of exemplary innovations.

These were heady days. Cawelti (1967) reflects the spirit of the time in the opening sentence of a review of "innovative practices in high schools": "Innovation is one of the *magic words* influencing school planning in 1967" (p. 1, my emphasis). And it was. The contributions of this adoption era included putting innovation and change into the national consciousness and mobilizing the development of new ideas, resources, and efforts of innovators at all levels of the educational system.

Some fundamental flaws, however, became apparent. The first was the assumption that developing major innovations on a national scale and making them available would lead to widespread adoption. In Cawelti's (1967) survey of more than 7,000 high schools, an average of six out of twenty-seven identified innovations were reported to have been adopted. But this was a start and not by itself a fatal limitation. A second and more telling problem was that schools that reported "adoption" were in fact using the innovation hardly at all, let alone effectively. Cawelti reports a "high abandonment" rate for many of the innovations. In considering how to evaluate the impact of innovations in the 1960s, Charters and Jones (1973) worried about "the risk of appraising nonevents." A third, unquestioned assumption of the day was that innovation was "good." To be innovating was to be on the cutting edge; to question or show disinterest was to be a laggard. Change for the sake of change had the upper hand because innovation was the name of the game. A fourth defect was the strategy assumption that you could accomplish change on the ground from afar. Federal initiative would find its way into local practice.

Implementation Problems

The second phase occurred abruptly. Around 1970, almost overnight, innovation got a bad name. The term *implementation*—what was happening (or not happening) in practice—came into use. Goodlad and his colleagues' (1973) *Behind the Classroom Door*, Sarason's (1971) *The Culture of the School and the Problem of Change*, Gross and associates' (1971) *Implementing Organizational Innovations*, and Smith and Keith's (1971) *Anatomy of Educational Innovation* exposed the problem. People were adopting innovations without asking why, and they were giving no forethought to follow through. Most of the 1970s was a decade of acknowledged failure. The economy was stagnant; there was a surplus of teachers; and from an innovation perspective, the focus was on "failed implementation." Although the initial implementation studies told us what *not* to do, after 1975 we gradually began to look for factors related to successful implementation. Alan Pomfret and I conducted a major review of implementation, and we identified fourteen "determinants of implementation" under four categories:

A. Characteristics of the Innovation
    1. Explicitness (what, who, when, how)
    2. Complexity

B. Strategies
    1. In-service training
    2. Resource support (time and materials)
    3. Feedback mechanisms
    4. Participation

C. Characteristics of the Adopting Unit
    1. Adoption process
    2. Organizational climate
    3. Environmental support
    4. Demographic factors

D. Characteristics of Macro Sociopolitical Units
    1. Design questions
    2. Incentive system
    3. Evaluation
    4. Political complexity (Fullan and Pomfret 1977, pp. 367–368)

Our confidence in the validity of these factors was buoyed by the fact that the evidence was coming from a variety of research and practice traditions that were compatible but were arrived at seemingly independently. Implementation research and practice, school improvement, effective schools, staff development (e.g., coaching), and leadership (e.g., the role of the principal) all more or less independently documented success stories and provided lists of key factors and processes associated with these accomplishments.

Clearly we were getting somewhere. We were now in a position to identify key factors for putting chosen innovations into practice. Armed with this knowledge, we could do a better job of planning for successful implementation. Moreover, local schools and school districts were paying more attention to developing the instructional leadership of principals, using effective schools research, and providing staff development. The federal role was still evident. Maybe federal and local initiatives could become connected (the role of states was still relatively dormant). Berman and McLaughlin (1977) provided the most comprehensive study of the implementation of federally sponsored programs. In addition to confirming many examples of failed implementation, Berman and McLaughlin emphasized local orientation and capacity: districts and schools fared better when they had a "problem solving" versus an "opportunistic" approach to new initiatives; received active support from principals and other administrators; engaged in ongoing inservice and support focused on the innovation; and, above all, engaged in a process of "mutual adaptation." Instead of attempting to implement innovations "faithfully" (the fidelity perspective) according to their initial design, local users had to interact with the innovation, reworking and redeveloping it according to local needs and contexts (mutual adaptation).

We were making progress, but we still had nagging doubts and problems. First, we still did not know enough about the dynamics of change. It was one thing to have a list of factors, and another to know how these factors interact and unfold. We did not have enough insights about the "microprocesses" of successful change projects. Second, and more fundamentally, we gained a growing realization that knowing how to implement single innovations, one at a time, was not the full story. Schools were not in the business of implementing innovations one after the other. They were in the business of implementing *multiple innovations simultaneously*.

Multiple Innovations

The futility of attempting to implement one innovation at a time, even substantial innovations, was attacked forcefully by the National Commission on Excellence in Education with the publication of *A Nation at Risk* in 1983. The book's subtitle contained the new call to arms: "The Imperative for Educational Reform." The Carnegie Forum's (1986) *A Nation Prepared: Teachers for the 21st Century* and the National Governors' Association's (1986) *A Time for Results* were two among several high-powered, nationwide mandates for action that followed, not to mention the many omnibus reform bills passed at the state level across the United States. Everyone seemed to agree that comprehensive reform was urgently needed.

During the 1980s, educators attempted more basic reform through two strategies, frequently but not always incompatible. These developments involved, respectively, a greater state role and site-based restructuring. In the last half of the 1980s, states led more reform activity than in the previous twenty-five years. The federal share of expenditures for elementary and secondary education declined from 8.7 percent in 1981 to 6.2 percent in 1989. By contrast, state funds rose dramatically. Between 1982–83 and 1986–87, state funding climbed over 21 percent, adjusted for inflation, although it has since leveled off (Firestone, Fuhrman, and Kirst 1989). The share of state funding of local school revenues has risen to a high of 50.7 percent (compared with 40 percent in 1970), with local districts at 42.5 percent and the federal government at 6.8 percent (p. 43). Part and parcel of greater funding was increased legislation and policy requirements.

At the same time, many states and school districts pursued "restructuring" strategies that sought to empower schools to work on shared governance and schoolwide improvement. The federally funded Center for Policy Research and Education (CPRE) has been tracking these state and reform initiatives. Firestone and colleagues (1989) report that every state joined in the movement to address the concerns raised in *A Nation at Risk*. We can examine these developments more closely through CPRE's study of six states: Arizona, California, Florida, Georgia, Minnesota, and Pennsylvania. In 1986, CPRE began a five-year tracer study of the implementation and effects of the reforms in these six states, which were chosen for their diverse approaches to reform. The states were selected to differ on scope of reform (comprehensive vs. small pieces), strategies used (mandates vs. other approaches like building local capacity), and geographical location (representative of regions). Firestone and associates report that:

> California, Florida and Georgia undertook comprehensive reform, symbolized by one major piece of legislation . . . . Reform in the other states was more incremental . . . . Florida, Georgia and Pennsylvania counted on state mandates to change local behavior. California used inducements and Minnesota favored strategies that build local capacity and broadened the state system of service providers. Arizona's plan balanced mandates and inducements (p. 1).

Among the main interim findings, after three years of study, are the following:

- All six states passed special legislation focusing on student standards (and curriculum), teacher policies, and corresponding finances.
- Strategies and policy instruments varied according to tradition and state political culture. For example, California used comprehensive reform and incentives; Georgia mandated reform.

- Most state reform packages lacked coherence. It was not that specific provisions conflicted, but that they were unrelated. The exception was California, where the state superintendent orchestrated the integration of existing and new provisions and coordinated implementation requirements.
- First-order changes involving graduation requirements, curriculum specifications, and the like, were more likely to occur and be retained than second-order changes involving career ladders, new decision-making structures, and so forth.
- District responses were crucial and varied greatly.

The state-level strategies have had differential success. Those that pursued a high-stakes testing strategy fared less well. Corbett and Wilson (1990) identified several unintended consequences, including the diversion of attention and energy from more basic reforms in the structure and practice of schools and reduced teacher motivation, morale, and collegial interaction necessary to bring about reform. They conclude: "When the modal response to statewide testing by professional educators is typified by practices that even the educators acknowledge are counterproductive to improving learning over the long term, then the issue is a 'policymaking problem'" (p. 321).

On the other hand, aggressive state leadership that coupled comprehensive focus with local district and school development did have an impact (Odden and Marsh 1988). Nonetheless, the key variable seemed to be local district capacity. State-level strategies can go only so far in affecting the district.

Site-based restructuring, however, has its own problems. It may have altered governance procedures, but does not necessarily affect the teacher-learning core of schools. Taylor and Teddlie (1992) found this to be true in their study of the extent of classroom change in "a district widely acclaimed as a model of restructuring" (p. 4). They examined classrooms in thirty-three schools [sixteen from pilot schools that had established school-based management (SBM) programs and seventeen from nonpilot schools in the same district]. Taylor and Teddlie found that teachers in the pilot schools reported higher levels of participation in decision making, but they found *no* differences in teaching strategies used. In both sets of schools, instruction continued to be teacher directed, with low student involvement. Further, there was little evidence of teacher collaboration. Extensive collaboration was reported in only two of the thirty-three schools—and both were from nonpilot schools. Taylor and Teddlie observe:

> Teachers in this study did not alter their practice . . . . Increasing their participation in decision-making did not overcome norms of autonomy so that teachers would feel empowered to collaborate with their colleagues (p. 10).

Other evidence from classroom observations failed to indicate changes in classroom environments and student learning activities. Despite considerable rhetoric and what Taylor and Teddlie saw as "a genuine desire to professionalize teaching," "the core mission of the school seemed ancillary to the SBM project" (p. 19). Substantive changes in pedagogy (teaching strategies and assessment) and in the way teachers worked together on instructional matters proved to be elusive. These findings would not be as noteworthy, claim the authors, except for the fact that "the study occurred in a district recognized nationally as a leader in implementing restructuring reforms" (p. 16). Similarly, Hallinger, Murphy, and Hausman (1991) found that teachers and principals in their sample were highly in favor of restructuring, but did not make connections "between new governance structures and the teaching-learning process" (p. 11).

Virtually identical findings arise in Weiss' (1992) investigation of shared decision making (SDM) in twelve high schools in eleven states in the United States (half were selected because they had implemented SDM; the other half were managed in a traditional, principal-led manner). Weiss found that teachers in SDM schools were more likely to mention decisions *about* the decision-making process (i.e., composition of committees, procedures, etc.) but that "schools with SDM did not pay more attention to issues of curriculum than traditionally managed schools, and pedagogical issues and student concerns were low on the list for both sets of schools" (p. 2).

Similar findings were obtained in the implementation of the Chicago Reform Act of 1989. In essence, this legislation shifted responsibility from the Central Board of Education to Local School Councils (LSCs) for each of the city's 540 public schools and mandated that each school develop School Improvement Plans (SIPs). The LSCs by law consist of eleven or twelve members (six parents, two teachers, two community representatives, the school principal—and in the case of high schools, a student). Easton (1991) reports that the majority of elementary teachers said that "their instructional practices had not changed as a result of school reform and will not change as a result of SIP" (p. 41).

In summary, the 1990s represent a new potential watershed. We have learned that neither centralization (federal or state or district) nor decentralization (school) by itself works. We also see that reform strategies struggle between *overcontrol* and *chaos* (Pascale 1990). The realization that initiating multiple innovations is the problem has shifted our attention to more comprehensive perspectives, but has failed to provide a solution. Evidently, change is more complex than we realized.

Systemic Reform

The response to the need to map and carry out comprehensive reform has been to advocate "systemic" strategies (Smith and O'Day 1990). Assessment, curriculum and instruction, staff development, personnel selection and promotion, and state/district/school action—hitherto uncoordinated—are to be systemically linked. The National Board for Professional Teaching Standards (NBTS 1992), focusing on "what teachers should know and be able to do," represents one component. The New Generation of American Schools "winning designs" program represents another as they attempt to integrate curriculum, school and community, structure and governance, and technology and assessment ("Winning Designs" 1992). The limitations of the systemic strategy are twofold. First, people vastly underestimate the dynamic complexity of how systems operate. Second, even if we coordinate the systemic components in one situation, we cannot necessarily extend the process to new situations. For example, producing good systemic ideas either through NTBS or through the New Generation of American Schools is not the same as seeing them spread to new situations. For the latter, we need a different paradigm.

What We Have Learned

We have come a long way in our short history of fifty years. We are now at the early stage of a much more complex phase of unpredictable and dynamic complexity. The next phase—essentially the beginning of the next century—will either build on or ignore the key lessons of the past half-century of experience with educational innovation and reform. I see eight main lessons,* each of which represents dilemmas, with corresponding lines of action. I believe these lessons represent a new mindset about educational change, one that is more in tune with systemic reality and dynamic complexity (see Fullan in press a).

---

* My thanks to Matt Miles, who has identified several of these lessons (Fullan and Miles 1992).

730

Senge (1990) makes the distinction between "detailed complexity" and "dynamic complexity." The former involves identifying all the variables that could influence a problem. Even this would be enormously difficult for one person or a group to orchestrate. But detailed complexity is not reality. Dynamic complexity is the real territory of change—"when 'cause and effect' are not close in time and space and obvious interventions do not produce expected outcomes" (Senge, p. 365) because other "unplanned" factors dynamically interfere. And we keep discovering, as Dorothy in Oz did, that "this is not Kansas anymore." Complexity, dynamism, and unpredictability, in other words, are not merely things that get in the way. They are *normal*. Such a mindset allows us to uncover a number of basic lessons about the process of educational change.

Eight Lessons of Change

Lesson 1. You Can't Mandate What Matters.

Mandates are important. Policymakers have an obligation to set policies, establish standards, and monitor performance. But to accomplish certain kinds of purposes—in this case, important educational goals—you cannot mandate what matters, because what really matters for complex goals of change are skills, creative thinking, and committed action (McLaughlin 1990). Mandates are not sufficient; and the more you try to specify them, the more narrow the goals and means become. Teachers are not technicians.

To elaborate, you can effectively mandate things that (1) do not require thinking or skill to implement them and (2) can be monitored through close and constant surveillance. You can, for example, mandate the cessation of the use of the strap, or mandate a sales tax on liquor or gasoline. These kinds of changes do not require skill on the part of implementers to comply; and provided that they are closely monitored, they can be enforced effectively.

Even in the relatively simple case—detailed, not dynamic complexity—almost all educational changes of value require new (1) skills, (2) behavior, and (3) beliefs or understanding (Fullan 1991). For example, think of computers across the curriculum, teachers' thinking and problem-solving skills, developing citizenship and teamwork, integration of special education in regular classrooms, dealing with multiculturalism and racism, working with social agencies to provide integrated services, responding to *all* students in the classroom, cooperative learning, and monitoring the performance of students. All of these changes, to be productive, require skills, capacity, commitment, motivation, beliefs, and insights—and discretionary judgment on the spot. If there is one cardinal rule of change in the human condition, it is that you cannot *make* people change. You cannot force them to think differently or compel them to develop new skills.

Lesson 2. Change Is a Journey, Not a Blueprint.

Another reason that you can't mandate what matters, is that you don't know what is going to matter until you are into the journey. If change involved implementing single, well-developed, proven innovations one at a time, perhaps it could be blueprinted. But school districts and schools are in the business of implementing a bewildering array of multiple innovations and policies simultaneously. Moreover, restructuring reforms are so multifaceted and complex that solutions for particular settings cannot be known in advance. If you try to match the complexity of the situation with complex implementation plans, the process becomes unwieldy, cumbersome, and usually wrong.

Lesson 3. Problems Are Our Friends.

It seems perverse to say that problems are our friends, but we cannot develop effective responses to complex situations unless we actively seek and confront the real problems—which are in fact difficult to solve. Problems are our friends because it is only through immersing ourselves in problems that we can come up with creative solutions. Problems are the route to deeper change and deeper satisfaction. In this sense, effective organizations embrace problems rather than avoid them.

Louis and Miles (1990) found that the least successful schools they studied engaged in "shallow coping"—doing nothing, procrastinating, doing it the usual way, easing off, or increasing pressure—whereas the successful schools went deeper to probe underlying reasons and to make more substantial interventions, such as comprehensive restaffing, continuous training, and redesigning programs. Successful schools did not have fewer problems than other schools; they just coped with them better. Moreover, the absence of problems usually indicates that not much is being attempted. Smoothness in the early stages of a change effort is a sure sign that superficial or trivial change is being substituted for substantial change attempts.

Lesson 4. Vision and Strategic Planning Come Later.

Visions are necessary for success, but few concepts are as misunderstood and misapplied in the change process. Visions come later for three reasons. First, under conditions of dynamic complexity, people need a good deal of *reflective experience* before they can form a plausible vision. Vision emerges from, more than it precedes, action. Even then it is always provisional. Second, *shared* vision, which is essential for success, must evolve through the dynamic interaction of organizational members and leaders. This takes time and will not succeed unless the vision-building process is somewhat open ended. Third, skill development is essential because without skill, vision remains superficial. In other words, vision building takes work; but the delay in formation means that people pursue the vision more authentically while avoiding premature formalization.

Visions come later because the process of merging personal and shared vision takes time. The critical question is not whether visions are important, but *how* they can be shaped and reshaped, given the complexity of change. Deep ownership comes through the learning that arises from engagement in solving problems. In this sense, ownership is stronger in the middle of a successful change process than at the beginning, and stronger still at the end than at the middle or beginning. Ownership is a process as well as a state. Saying that ownership is crucial begs the question, unless you know how it is achieved.

Lesson 5. Individualism and Collectivism Must Have Equal Power.

Productive educational change is a process of overcoming isolation while not succumbing to groupthink. There are few more endemic paradoxes in humankind than the creative tension between individual and group development.

Teaching has long been called "a lonely profession," always in pejorative terms. The professional isolation of teachers limits access to new ideas and better solutions; fails to recognize and praise success; and permits incompetence to exist and persist to the detriment of students, colleagues, and the teachers themselves. Isolation allows, even if it does not always produce, conservatism and resistance to innovation in teaching (Lortie 1975).

Isolation also imposes a ceiling effect on inquiry and learning. Solutions are limited to the experiences of the individual. Complex change depends on the efforts of many people working insightfully on the solution and committing themselves to concentrated action together.

Educational problems are complex; collaborative "learning enriched" schools do better than those lingering with the isolationist traditions of teaching (Rosenholtz 1989, Fullan and Hargreaves 1991). Site-based management, peer coaching, and mentoring become valued strategies.

There is nothing automatically good, however, about collaboration. Pushed to extremes, it becomes groupthink—uncritical conformity, unthinking acceptance of the latest solution, and suppression of individual dissent. Groups are more vulnerable to faddism than are individuals. Having a healthy respect for individuals and for personal visions is a source of renewal when the future is unknown and the environment is changing in unpredictable ways. The most productive schools value individualism *and* collectivism simultaneously (Nias, Southworth, and Campbell 1992).

Lesson 6. Neither Centralization nor Decentralization Works.

Centralization errs on the side of overcontrol, decentralization errs toward chaos. We have known for decades that top-down change doesn't work (Lesson 1: You can't mandate what matters). Leaders keep trying because they don't see any alternative, and they are impatient for results (either for political or moral reasons). Decentralized solutions like site-based management also fail because groups get preoccupied with governance and frequently flounder when left on their own.

To put it most clearly, individual schools can become highly collaborative despite the school system they are in, but they cannot *stay* highly collaborative despite their systems. Key people leave, people get transferred, and so on. Two-way, top-down/bottom-up solutions are needed in which schools and districts influence each other through a continually negotiated process and agenda (Fullan in press).

This process works in our Learning Consortium (Fullan in press b). For example, the Halton School Districts use the following strategies to integrate school- and district-level development:

- A broad-based mission statement and strategic directions (instruction, school planning, and staff development) provide a core focus while enabling flexibility.
- A school-growth planning process helps achieve continued growth geared to each community's context.
- Performance appraisals for teachers, vice-principals, and principals are integrated with the three strategic directions.

- A selection and promotion process for all staff stresses collaborative skills, staff development participation and leadership, implementation planning, and knowledge of the change process.
- Schools and districts make a systematic commitment to continuous development through allocating staff development funds to each school and conducting systemwide institutes.
- A reorganization of the system is designed to bring instructional support closer to the school, including in-school resource teachers and area support staff.
- A districtwide assessment and evaluation system provides periodic feedback into all processes.

Lesson 7. Connection with the Wider Environment Is Critical for Success.

Many schools work hard at internal development but fail to keep a proactive learning stance toward the environment. To prosper, schools must be actively plugged into their environments; schools must respond to the issues of the day—and contribute to them. Schools must engage state policies (not necessarily implement them literally), if they are to protect themselves from wrongheaded imposition.

Rosenholtz's (1989) "moving" schools were not disrupted by the latest state policies. Because these schools were proactive, they actively endorsed and enlarged certain state policies. These schools could also blunt or openly challenge other policies that they perceived as wrong or undeveloped.

In the same vein, in England, Nias and her colleagues (1992) found that collaborative schools committed to teacher learning reacted differently from other schools to the National Curriculum. Collaborative schools neither wholeheartedly rejected nor embraced the reform, but considered the whole school curriculum in a way that was open to the external stimulus. Nias and her colleagues conclude:

> The staff of these schools used an external initiative which they might have seen as a constraint to serve their own educational purposes. In the process they came to feel both that it was part of their own curricular thinking and that they were in control of it. That is, by the time that our fieldwork ended, the staff in these schools felt that they "owned" the relevant parts of the National Curriculum (p. 195).

"Learning" schools know that there are far more ideas "out there" than "in here." Successful schools tap into these ideas and contribute to the demands of change that are constantly churning around in the environment.

Thus teachers in Rosenholtz's (1989) "moving" schools believed that good teachers never stopped learning. They were more likely to value the sharing of expertise, and they sought advice and help both inside and outside (see also Fullan in press a).

Lesson 8. Every Person Is a Change Agent.

For two reasons, *every person* working in an enterprise committed to making continuous improvements must be effective at managing change. First, because no one person can possibly understand the complexities of change in postmodern society, we cannot leave the responsibility to others. Second, and more fundamental, the conditions for the new paradigm of change to thrive cannot be established by formal leaders working by themselves. Each teacher has the responsibility to help create an organization capable of individual and collective inquiry and continuous renewal, or it will not happen. Only when individuals take action to alter their own environments is there any chance for deep change. As more people take such action, they have greater chances of intersecting and of forming the critical mass necessary for system change.

What Lies Ahead?

There is no question that the focus has shifted from an innovation concern to a reform and restructuring agenda. Three major strategic issues face the educational system. The first is whether the public system itself will survive given the combination of fewer economic resources, public dissatisfaction, deteriorating social and economic conditions in large cities, growing teacher stress, and the push for a free-market choice system. A lot will depend on how the remaining two strategies fare.

The second strategic area relates to how much substantial progress will be made on "systemic" reform. We need concrete, knowledge- and skill-based examples of systemic reform in action in which actual connections are made through implementing new designs. We should see some development along these lines in the New Generation of American Schools, because the "winning designs" are attempts to achieve synergy of curriculum, technology, teacher development, assessment, structure and governance, and school-external agencies. The development of these new models per se is not a strategy for widespread change, because the latter always requires local development, not just borrowing good ideas. We may also see progress at the state level, because many states are seeking systemic integration among curriculum, assessment, staff development, and school development. The key will be to restructure so that bottom-up and top-down initiatives can feed on each other. This process requires not only greater *systemic* emphasis, but also a much stronger knowledge and skill base about teacher learning. In other words, both systemic connections and good ideas will be necessary. You have to have something worthwhile to connect; and even if it is worthwhile it must be evident in the day-to-day skilled practice of teachers.

The third area that requires much attention is the relationship between *restructuring* and *"reculturing"*—establishing a culture conducive to change.*Change cultures* encompass the values, beliefs, norms, and habits of collaboration and continuous improvement as, for example, contained in the eight lessons. Restructuring, such as site-based management, as many have found out, does not by itself result in reculturing. In most restructuring reforms, the structure attempts to push cultural change, and mostly fails (Fullan in press b). Clearly there must be a reciprocal relationship between the two; but restructuring might be more effective if the attempted conceptual and normative changes were to accumulate to drive structural changes conducive to new ways of working. When teachers and administrators begin working in new ways and, in the process, discover that school structures must be altered, reform and restructuring are much more powerful and meaningful than when the reverse happens. Rapidly implemented new structures create confusion, ambiguity, and conflict, ultimately leading to retrenchment. Therefore, we need to work directly on revamping and upgrading the profession of teaching and teacher education, from preservice throughout the career. At the same time, new school cultures must evolve in which continuous teacher development and continuous school development go hand in hand. Many examples of this are now happening in the works of Comer, Levin, Sizer, and others; but these are only small pockets of activity compared with what will be needed.

* * *

The past fifty years have been the formative ones in establishing the field of educational change. Our knowledge of the change process, and insights into the dynamics of what makes for unsuccessful and successful change have become considerably sophisticated. At the same time, the problems and society have become more complex, which means that the change process has become more complex and intractable. We have learned that understanding even complex change processes is only half the battle. Doing something about it is far more of a challenge, which should occupy us for years to come.

References

Berman, P., and M. McLaughlin. (1977). *Federal Programs Supporting Educational Change*. Vol. 7. Factors Affecting Implementation and Continuation. Santa Monica, Calif.: Rand Corporation.

Carnegie Forum on Education and the Economy. (1986). *A Nation Prepared: Teachers for the 21st Century*. (Report of the Task Force on Teaching as a Profession). New York: Carnegie Corporation.

Cawelti, G. (1967). "Innovative Practices in High Schools: Who Does What and Why and How." In *The Nation's Schools*, edited by G. Cawelti. New York: McGraw-Hill.

Charters, W., and J. Jones. (1973). *On the Neglect of the Independent Variable in Program Evaluation*. (Occasional paper). Eugene: University of Oregon.

Corbett, H.D., and B. Wilson. (1990). *Testing, Reform and Rebellion*. Norwood, N.Y.: Ablex.

Easton, J. (1991). *Decision Making and School Improvement*. Chicago: Chicago Panel on Public School Policy and Finance.

"Winning Designs for a New Generation of American Schools." (1992). *Education Week*.

Firestone, W., S. Fuhrman, and M. Kirst. (1989a). *The Progress of Reform: An Appraisal of State Education Initiatives*. New Brunswick, N.J.: Rutgers University Center for Policy Research in Education.

Fullan, M. (in press a). *Change Forces: Probing the Depths of Educational Reform*. London: Falmer Press.

Fullan, M. (in press b). "Coordinating School and District Development in Restructuring." In *Restructuring Education: Learning from Ongoing Efforts*, edited by J. Murphy and P. Hallinger. Calif.: Corwin Publishers.

Fullan, M., with S. Stiegelbauer. (1991). *The New Meaning of Educational Change*. New York: Teachers College Press.

Fullan, M., and A. Hargreaves. (1991). *What's Worth Fighting For? Working Together for Your School*. Toronto, Ontario, Canada: Ontario Public School Teachers' Federation; Andover, Mass.: The Network.

Fullan, M., and M. Miles. (1992). "Getting Reform Right: What Works and What Doesn't." *Phi Delta Kappan* 73, 10: 744-52.

Fullan, M., and A. Pomfret. (1977). "Research on Curriculum and Instruction Implementation." *Review of Educational Research* 47, 1: 335-37.

Goodlad, J.I., M. Klein, and associates. (1970). *Behind the Classroom Door*. Worthington, Ohio: Charles A. Jones.

Gross, N., J. Giacquinta, and M. Bernstein. (1971). *Implementing Organizational Innovations: A Sociological Analysis of Planned Educational Change*. New York: Basic Books.

Hallinger, P., J. Murphy, and Housmann. (1991). "Conceptualizing School Restructuring: Principals' and Teachers' Perceptions." Paper presented at the Annual Meeting of the American Research Education Association.

Lortie, D. (1975). *School Teacher: A Sociological Study*. Chicago: University of Chicago Press.

Louis, K., and M. Miles. (1990). *Improving the Urban High School: What Works and Why*. New York: Teachers College Press.

McLaughlin, M. (1990). "The Rand Change Agent Study Revisited." *Educational Researcher* 19: 11-16.

Murphy, J. (1992). *Restructuring Schools: Capturing the Phenomenon*. New York: Teachers College Press.

National Commission on Excellence in Education. (1983). *A Nation at Risk*. Washington, D.C.: National Commission on Excellence in Education.

National Governors' Association. (1986). *A Time for Results*. Washington, D.C.: National Governors' Association.

Nias, J., G. Southworth, and P. Campbell. (1992). *Whole School Curriculum Development in the Primary School*. Philadelphia: Falmer Press.

Odden, A., and D. Marsh. (1988). "How Comprehensive Reform Legislation Can Improve Secondary Schools." *Phi Delta Kappan* 68, 8: 593-598.

Pascale, R. (1990). *Meaning on the Edge*. New York: Simon and Schuster.

Rosenholtz, S. (1989). *Teachers' Workplace: The Sound Organization of Schools*. New York: Longman.

Sarason, S. (1971). *The Culture of the School and the Problem of Change*. Boston: Allyn and Bacon.

Sarason, S. (1990). *The Predictable Failure of Educational Reform*. San Francisco: Jossey Bass.

Senge, P. (1990). *The Fifth Discipline*. New York: Doubleday.

Smith, L. and P. Keith. (1971). *Anatomy of Educational Innovation: An Organizational Analysis of an Elementary School*. New York: Wiley.

Smith M.., and J. O'Day. (1990). "Systemic School Reform." In *The Politics of Curriculum and Testing* (pp. 233-267), edited by S. Furham and B. Malen. Philadelphia: Falmer Press.

Taylor, D., and C. Teddlie. (1992). "Restructuring and the Classroom: A View from a Reform District." Paper presented at the Annual Meeting of the American Educational Research Association, San Francisco.

Weiss, C. (1992). "Shared Decision Making About What?" Paper presented at the Annual Meeting of the American Educational Research Association, San Francisco.

Reprinted with permission of the authors from "Assessing Progress Toward Systemic Reform: Improving Mathematics and Science Learning by Douglas S. Fleming, Barbara A. Fleming, and Charles Mojkowski. (c) 1994.

Assessing Progress Toward Systemic Reform: Improving Mathematics and Science Learning

Directions: Complete this assessment as a team by circling the assessment response that best matches your school's current status. After you have responded to all items, select the **five** "need to starts" you consider most important to address soon. Then select the **five** "doing wells" you consider to be your most significant accomplishments. List these at the end of the form.

Developing a Systemic Perspective		**Assessment**	
We have involved all stakeholders in our planning program (families, community, business).	need to start	can improve	doing well
The School Committee understands and supports our program.	need to start	can improve	doing well
The central office understands and supports our program.	need to start	can improve	doing well
We have made connections to other organizations where children learn (homes, museums, university and colleges, nature centers, Boys' and Girls' Clubs, libraries, etc.).	need to start	can improve	doing well
Our program is linked to our overall school improvement plan.	need to start	can improve	doing well
We are building collaborations with other organizations to foster innovative professional development opportunities.	need to start	can improve	doing well
Enhancing and Expanding Programs			
We are broadening our base of support by adding new partners in our project.	need to start	can improve	doing well
We are involving more teachers with our program this year.	need to start	can improve	doing well
Our teachers are doing demonstration lessons in each other's classrooms.	need to start	can improve	doing well

We have expanded our initial partnerships with colleges, universities, businesses, and the community.	need to start	can improve	doing well
We are looking for additional funding to insure that our program will continue on its own.	need to start	can improve	doing well
We are looking for ways to make resources more easily available to our teachers.	need to start	can improve	doing well

Defining Standards for Effective Science and Mathematics Learning

We have identified the key knowledge and skill areas that mark quality science learning	need to start	can improve	doing well
We have identified the key knowledge and skill areas that mark quality mathematics learning.	need to start	can improve	doing well
We have identified essential practices, conditions, and resources students need in order to learn science and mathematics well. For example:			
Time in class to measure, observe, and manipulate data	need to start	can improve	doing well
Time in class doing hands-on activity	need to start	can improve	doing well
Time in class to make predictions and test hypothesis	need to start	can improve	doing well
Time in class to raise questions and identify problems	need to start	can improve	doing well

Developing Curriculum Guides/Materials

Our school mathematics and science programs are organized around the standards identified for effective mathematics and science learning.	need to start	can improve	doing well

Our curriculum outlines the major concepts we want our students to know.	need to start	can improve	doing well
Our curriculum articulates the skills we want our students to be able to demonstrate.	need to start	can improve	doing well
We are making connections to the state curriculum frameworks currently under development.	need to start	can improve	doing well
Our curriculum identifies the attitudes or habits that we prize highly.	need to start	can improve	doing well

Enhancing Instructional Practices

Classroom instruction features:

Hands-on activities through which students discover principles and relationships	need to start	can improve	doing well
Group activities in which students work cooperatively in solving problems	need to start	can improve	doing well
Use of technology as a tool for measuring, observing, recording, reporting, and assessing data or information	need to start	can improve	doing well
Opportunities for students to make choices and to plan, conduct, and evaluate independent investigations	need to start	can improve	doing well
Emphasis on demonstrating understanding over memorization of facts and formulas	need to start	can improve	doing well

Improving Student Assessment

We use projects to help us observe students at work.	need to start	can improve	doing well
We assign performances to help us measure students' understanding and ability to apply what they have learned.	need to start	can improve	doing well

We maintain portfolios of student work to reflect growth over time and to document unique talents and skills.	need to start	can improve	doing well
We use peer reviews as a way of helping students to become thoughtful, critical assessors of their own work and that of others.	need to start	can improve	doing well
We use personal conferences with each student to reflect on progress, accomplishments, and new directions for student effort.	need to start	can improve	doing well
ALL students have equal access to resources and programs for learning science and mathematics.	need to start	can improve	doing well
An increasing number of minorities and female students are showing an interest in science and mathematics.	need to start	can improve	doing well
We screen our curriculum materials and activities for gender, race, and ethnic group bias.	need to start	can improve	doing well

Providing Staff Development Opportunities

Teachers participate in college or university level programs for graduate credit or meet continuing education requirements.	need to start	can improve	doing well
Teachers participate in workshops sponsored by regional collaboratives.	need to start	can improve	doing well
Teachers attend on-site sessions aimed at strengthening science and mathematics learning.	need to start	can improve	doing well
Teachers observe each other teaching science and mathematics lessons.	need to start	can improve	doing well
Teachers conduct action research projects and report their findings.	need to start	can improve	doing well

Teachers participate in face-to-face networking meetings sponsored by the district, regional collaboratives, or state organizations.	need to start	can improve	doing well
We have tied our program to the ongoing professional development program in our school.	need to start	can improve	doing well

Involving Parents and Community Members

Parents and community members come into classrooms to talk about their careers or to teach a relevant lesson in science or mathematics.	need to start	can improve	doing well
Our school holds a science, math, or technology night for families.	need to start	can improve	doing well
We offer a "Family Math" or "Family Science" program.	need to start	can improve	doing well
We include parents and community members in science, mathematics, and technology curriculum development committees.	need to start	can improve	doing well
Parents and community members serve as mentors for students.	need to start	can improve	doing well
We encourage parents and community members to volunteer in classrooms.	need to start	can improve	doing well
We prepare parents for assisting with science and mathematics lessons.	need to start	can improve	doing well
We send home science and mathematics learning activities and families can do with their children.	need to start	can improve	doing well
We hold "Come to School Nights" so families and community members can learn first hand about changes in education--portfolio assessment, multimedia, multiage grouping, interdisciplinary curriculum, etc.	need to start	can improve	doing well

Improving Evaluation

We are documenting the accomplishments or our objectives.	need to start	can improve	doing well
We periodically review our progress and milestones.	need to start	can improve	doing well
We meet regularly to make mid-course adjustments based on review of information about our program.	need to start	can improve	doing well

---

Important "Need to Starts"	Most Significant "Doing Wells"

APPENDIX A

Regional Educational Laboratories A-1

Regional Educational Laboratories

(and the regions they serve)

Appalachia Educational Laboratory (AEL)
Post Office Box 1348
Charleston, WV 25325
Phone: 304-347-0400; Fax: 304-347-0487
Contact: Ray Francis
(Kentucky, Tennessee, Virginia, and West Virginia)

Far West Laboratory for Educational Research and Development (FWL)
730 Harrison Street
San Francisco, CA 94107-1242
Phone: 415-565-3000; Fax: 415-565-3012
Contact: David Nickles
(Arizona, California, Nevada, and Utah)

Mid-continent Regional Educational Laboratory (McREL)
2550 South Parker Road, Suite 500
Aurora, CO 80014
Phone: 303-337-0990; Fax: 303-337-3005
Contact: John Sutton
(Colorado, Kansas, Missouri, Nebraska, North Dakota, South Dakota, and Wyoming)

North Central Regional Educational Laboratory (NCREL)
1900 Spring Road, Suite 300
Oak Brook, IL 60521
Phone: 708-571-4700; Fax: 708-571-4716
Contact: Cathy Cook
(Illinois, Indiana, Iowa, Michigan, Minnesota, Ohio, and Wisconsin)

Northwest Regional Educational Laboratory (NWREL)
101 S.W. Main Street, Suite 500
Portland, OR 97204
Phone: 503-275-9500; Fax: 503-275-9489
Contact: Janet May
(Alaska, Idaho, Oregon, Montana, and Washington)

Pacific Region Educational Laboratory (PREL)
828 Fort Street Mall, Suite 500
Honolulu, HI 96813
Phone: 808-533-6000; Fax: 808-533-7599
Contact: Winona Chang
(American Samoa, Commonwealth of the Northern Mariana Islands, Federated States of Micronesia, Guam, Hawaii, Republic of the Marshall Islands, and Republic of Palau)

The Regional Laboratory for Educational Improvement of the Northeast and Islands (NE&I)
300 Brickstone Square, Suite 950
Andover, MA 01810
Phone: 508-470-0098; Fax: 508-475-9220
Contact: Eileen Ferrance
(Connecticut, Maine, Massachusetts, New Hampshire, New York, Puerto Rico, Rhode Island, Vermont, and the Virgin Islands)

Research for Better Schools (RBS)
444 North Third Street
Philadelphia, PA 19123
Phone: 215-574-9300; Fax: 215-574-0133
Contact: Janice Dilliplane-Kruse
(Delaware, District of Columbia, Maryland, New Jersey, and Pennsylvania)

SouthEastern Regional Vision for Education (SERVE)
345 South Magnolia Drive, #E22
Tallahassee, FL 32301
Phone: 904-671-6033; Fax: 904-671-6010
Contact: Cheryl Cliett
(Alabama, Florida, Georgia, Mississippi, North Carolina, and South Carolina)

Southwest Educational Development Laboratory (SEDL)
211 East Seventh Street
Austin, TX 78701-3281
Phone: 512-476-6868; Fax: 512-476-2286
Contact: Glenda Clark
(Arkansas, Louisiana, New Mexico, Oklahoma, and Texas)

APPENDIX B

Brainstorming B-1

Carousel Brainstorming B-2

Jigsaw B-3

Numbered Heads Together B-4

Pyramidal Process for Reaching Consensus B-5

Three-Step Interview B-6

Other Selected Techniques B-7

B-1 BRAINSTORMING

Desired Outcome for Participants:

- To generate as much information as possible relative to a given question or issue.

Materials:

- **Transparency:**
  - *Rules of Brainstorming* (B-1-3)
- Overhead projector and screen
- Newsprint, easel, markers, and tape

Facilitator's Notes: In any brainstorming session, the principles should be reviewed with participants before beginning. Some of them are listed below:

- We will produce more ideas if we refrain from evaluating them or discussing them at the time they are proposed. This is important because education and experience have trained most of us to think judiciously rather than creatively. By deferring judgment on our ideas, we can think up far more alternatives to choose from later.
- Group production of ideas can be more productive than separate, individual production of ideas. Experiments in group thinking have demonstrated that the average participant in this type of creative collaboration can think up twice as many possible solutions as when working alone.
- The more ideas we think up the better. In problem solving of almost any type, we are more likely to choose the right path toward a solution if we think up ten possible alternatives instead of only two or three.

It is also important to review the rules at the same time. Use the **Rules of Brainstorming (B-1-3)** transparency to summarize the rules.

In the first phase, BRAINSTORM responses according to the following rules:

- All critical judgment is ruled out. We seek ideas, not critical analysis.

- Wild ideas are expected in the spontaneity that comes when we suspend judgment. Practical considerations are not important at this point.
- Quantity of ideas counts here, not quality.
- Build on the ideas of other brainstormers when possible. Pool your wildness.

In the second phase, NO CRITICAL JUDGMENT is applied:

- Review the ideas by applying your best judgment.
- Search for clues to something sound in the wildest idea.
- Select priorities for reporting to the decision-making person or group.

Process:

1. Pose a focusing question to participants.
2. Review principles and rules for brainstorming using the **Rules of Brainstorming (B-1-3)** transparency.
3. Have participants respond (keeping in mind the rules). Chart all responses on newsprint.
4. Review ideas.

RULES OF BRAINSTORMING

- All ideas are okay
- Be creative
- Expand
- Then contract

B-2 CAROUSEL BRAINSTORMING

Desired Outcome for Participants:

- To generate as much information as possible relative to a given question or issue.

Materials:

- **Transparency:**
  - *Rules of Brainstorming* (B-1-3)
- Overhead projector and screen
- Newsprint, markers, and tape

Facilitator's Notes:

This exercise is good for generating a large number of ideas, alternatives, or responses to questions or issues. It is also a physically active exercise, good for times when participants' energy is low. Begin with a number of different questions, issues, or topics that you want to generate responses to.

Process:

1. Using the **Rules of Brainstorming (B-1-3)** transparency, review the rules with the group.
2. Write a series of topics or questions related to the issue being explored on the top of separate sheets of newsprint.
3. Post the newsprint on the walls, five to seven feet apart.
4. Divide participants (groups of four or five are best) and ask each group to stand at a sheet of newsprint. Explain that each group will remain together throughout the exercise.
5. Have each group choose a recorder while the remaining members brainstorm ideas on the topic for two minutes. The recorder writes the generated ideas on the newsprint.
6. At the end of two minutes, signal the groups to move one sheet to the right to the next sheet of newsprint. Groups read what is already written, then brainstorm and record their ideas at this new sheet for two minutes. Movement continues until all groups in the room have brainstormed on all the sheets of newsprint. Each group adds to the ideas of the group before them.

7. At the end of the exercise, have participants do a "gallery tour" to circulate and read what other groups have generated for each piece of newsprint in the room.

B-3 JIGSAW

Desired Outcome for Participants:

- To learn new content by becoming expert in a particular aspect of a topic and then teaching that material to others in the group.

Materials:

- **Transparencies:**
  - *Jigsaw Exercise* (B-3-3)
  - *Simple Jigsaw* (B-3-4)
- Overhead projector and screen
- The jigsaw requires a set of readings. If at all possible, these should be assigned and distributed in advance to allow for more thoughtful reading. Expert group time should then be shortened and devoted to discussion with peer "experts."

Facilitator's Notes: The advantage of using the jigsaw is that it provides a good way for participants to learn new content and an opportunity to reinforce that learning by teaching the content to others.

This technique provides a structured opportunity for people to read, think, and talk about the topic selected. It extends knowledge and stimulates good collegial thinking and discussion. This technique draws on the knowledge participants bring, promotes shared responsibility for learning, provides new feelings of expertise, and shifts the status of expert from trainer to learner.

Process:

1. Review the purpose of the exercise. Explain what a jigsaw is: a cooperative learning strategy developed at Johns Hopkins University that allows participants to become experts in a particular aspect of the topic and then to teach that aspect to others in the group.

2. Use the **Jigsaw Exercise (B-3-3)** or **Simple Jigsaw (B-3-4)** transparency to illustrate the structure and sequence of the exercise.

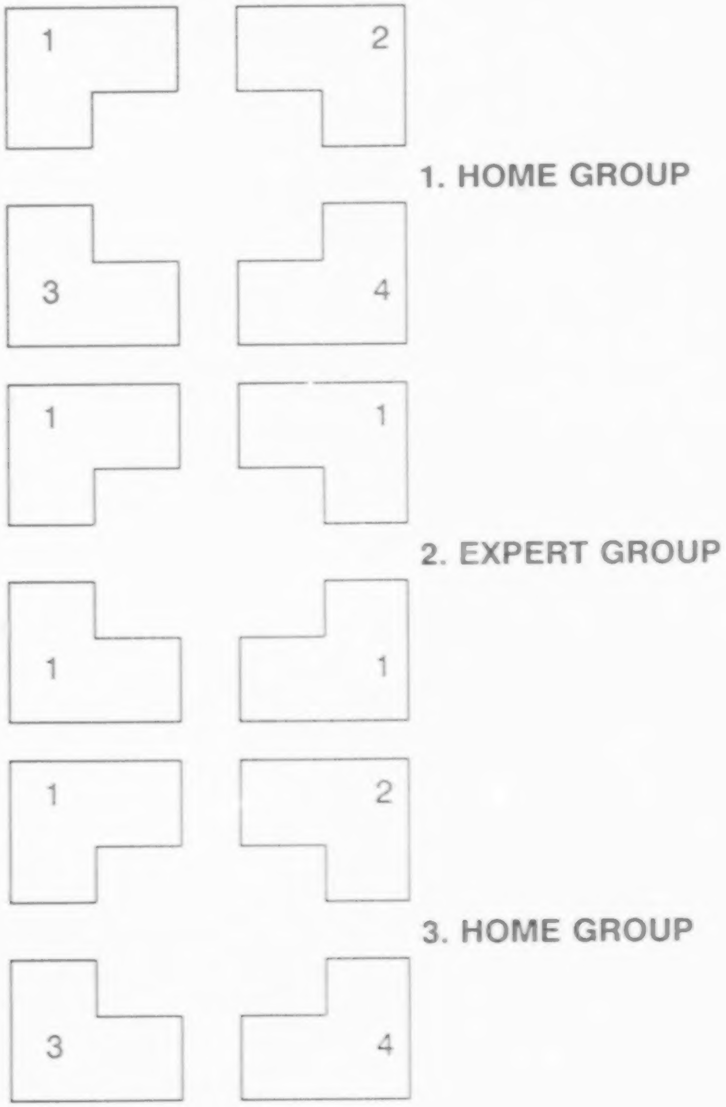
Source: This activity was adapted with permission of the Association for Supervision and Curriculum Development from *Human Resource Development Program Handbook: A Practical Guide for Staff Developers* by Cerylle A. Moffett and Cynthia L. Warger. ©1988.

3. Participants begin in home groups. Each member of the home group selects or is assigned a different reading. (In the **Jigsaw Exercise [B-3-3]** transparency, each home group has four members and there are four different readings.)

4. The home groups split into new groups called expert groups consisting of all those who were assigned the same reading. In the expert groups, members discuss what they have read, highlight major points, discuss questions suggested by the facilitator, and decide how they will teach the material to their home groups.

5. After a designated period of time, the home group reconvenes, with each member teaching the rest of the group what he or she has learned.

JIGSAW EXERCISE



1. HOME GROUP

2. EXPERT GROUP

3. HOME GROUP

Source: Adapted with permission of the Association for Supervision and Curriculum Development from *Human Resource Development Program Handbook: A Practical Guide for Staff Developers* by Cerylle A. Moffett and Cynthia L. Warger. ©1988.

SIMPLE JIGSAW

1. Break reading material down into three to five logical chunks or topics.

2. Divide participants into teams with the same number of members as topics. Each member of the team reads about a different topic.

3. Individual team members explain, report, or share the information they have mastered with the rest of their team.

4. All team members are responsible for mastering all material.

B-4 NUMBERED HEADS TOGETHER

Desired Outcome for Participants:

- To increase participation by every member of the group by making each responsible for his or her own learning and that of other members.

Materials:

- **Transparency:**
  - *Numbered Heads Together* (B-4-2)
- Overhead projector and screen

Facilitator's Notes: This is a cooperative learning exercise. It illustrates the amount of information that can be generated when all members of a group are active participants. In it, the group discusses a question or issue and a member is chosen at random to represent the group's responses.

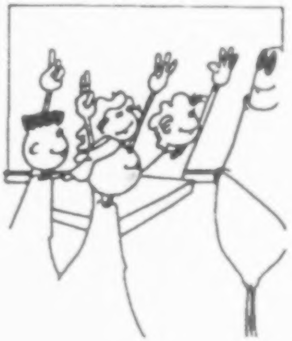
Process:

1. Show the **Numbered Heads Together (B-4-2)** transparency as you explain each step.
2. Divide participants into small groups. (Four is usually a good number, and is used in this example.) Have each member of each group pick a number from one to four.
3. The facilitator then asks a question, which the small groups discuss (i.e., put their heads together).
4. The facilitator then calls out a number between one and four, and everyone with that number raises his or her hand. The facilitator then calls on one person with a raised hand to answer for their group. The facilitator then asks another question, calls another number, calls on one person with a raised hand, etc.

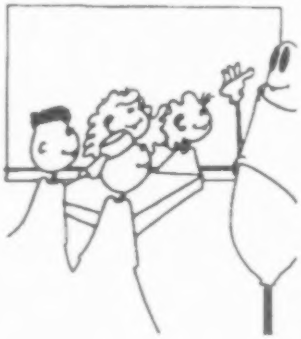
Source: This activity was adapted with permission of Kagan's Cooperative Learning Company from *Cooperative Learning* by Spencer Kagan. ©1992, 10-2 through 10-4.

NUMBERED HEADS TOGETHER

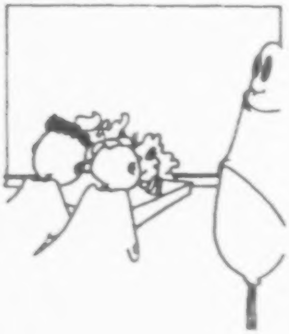
1. Team Members Number Off



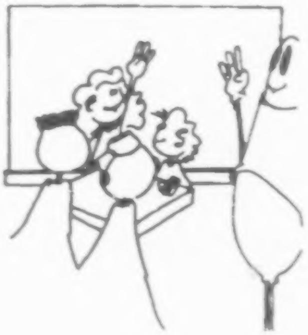
2. Facilitator Presents Problem



3. Heads Together



4. A Number is Called



Source: Reprinted with permission of Kagan's Cooperative Learning Company from *Cooperative Learning* by Spencer Kagan. ©1992, 10-3.

B-5 PYRAMIDAL PROCESS FOR REACHING CONSENSUS

Desired Outcome for Participants:

- To enable a sizable number of people to come to consensus on an issue, topic, or decision.

Materials:

- **Transparency:**
  - *Pyramidal Process for Reaching Consensus* (B-5-3)
- **Handouts:**
  - *The Pyramidal Process for Reaching Consensus* (B-5-4)
  - *Rules for Building Consensus* (B-5-5 and B-5-6)
- Overhead projector, screen, blank paper, and pens or pencils

Facilitator's Notes:

This process is most useful when a group needs to come up with a single position, definition, or statement. For example, it has been used effectively for developing mission statements.

The process is seldom completed in a day, but it is possible to arrive at two or three versions of whatever is being developed in the first session. It is useful for people to have some time to think about the various versions before trying to reach consensus on a single one. Often three or four sessions are necessary to complete the task.

Process:

1. Introduce the idea of consensus and the pyramidal process using the **Pyramidal Process for Reaching Concensus (B-5-3)** transparency and/or the handout **Pyramidal Process for Reaching Concensus (B-5-4)** and the handout **Rules for Building Consensus (B-5-5 and B-5-6)**.

2. Introduce and discuss the task at hand. For example, if the group is working on a mission statement, the characteristics of a well-written mission should be discussed and agreed to. Make sure everyone has a good grasp of what the final product will look like.

Source: *Building Systems for Professional Growth: An Action Guide* by Margaret A. Arbuckle and Lynn B. Murray. Andover, MA: The Regional Laboratory for Educational Improvement of the Northeast and Islands. ©1989, 4-35.

3. First, ask individuals to write their own version of whatever is developed.

4. After each person has written his/her own draft, ask participants to form pairs. Their task is to reach a consensual agreement on one statement that satisfies them both.

   Note: At this stage it is often necessary to review the "rules" of reaching consensus, using the handout **Rules for Building Consensus (B-5-5 and B-5-6)**.

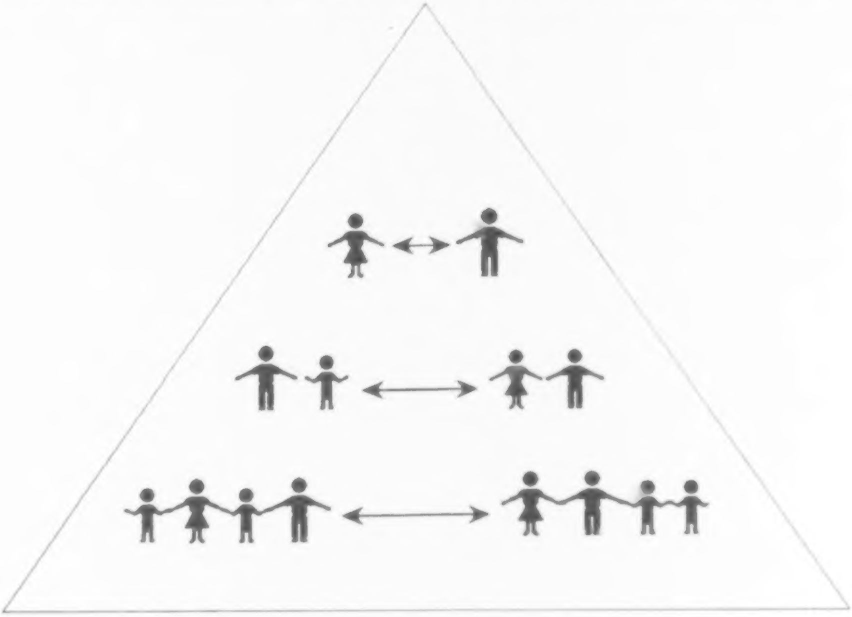
5. Each pair is then joined by another pair and the consensus-building process begins again.

6. The size of the consensus-building groups continues to grow until one product/statement is arrived at that every member of the group can agree with.

7. If the group appears to be stalemated – unable to agree on one version or another – the discussion and negotiation process can be speeded up by using a "fish bowl."

   The opposing groups each select one or two spokespersons for their point of view. The spokespersons form a circle of chairs in the middle of the room, with everyone else seated around them. They continue negotiations while the rest of the group observes; thus a "fish bowl" is formed. An empty chair or two should be provided in the circle for the observers to temporarily join the negotiations whenever they want to make a particular point or put forth a particular argument.

PYRAMIDAL PROCESS FOR REACHING CONSENSUS



PAIR: Share ideas/opinions/responses. Come to consensus on one statement.

PAIRS PAIR: Share ideas. Come to consensus on one statement.

QUADS PAIR: Share ideas. Come to consensus on one statement.

The size of the consensus group can grow until one statement is developed with which all participants agree.

Source: *Building Systems for Professional Growth: An Action Guide* by Margaret A. Arbuckle and Lynn B. Murray. Andover, MA: The Regional Laboratory for Educational Improvement of the Northeast and Islands. ©1989, 4-35.

THE PYRAMIDAL PROCESS FOR REACHING CONSENSUS

The process is most useful when a group needs to come up with a single position, definition, or statement. For example, it has been used effectively for developing mission statements.

1. Thoroughly introduce and discuss the task at hand. For example, if the group is working on a mission statement, the characteristics of a well-written mission should be discussed and agreed to. Make sure everyone has a good grasp of what the final product will look like.
2. First, ask individuals to write their own version of whatever is being developed.
3. After each person has written his/her own draft, pairs are formed. Their task is to reach a consensual agreement on one statement which satisfies them both.

   Note: At this stage it is often necessary to review the "rules" of reaching consensus.
4. Each pair is then joined by another pair and the consensus-building process begins again.
5. The size of the consensus-building groups continues to grow until one product/statement is arrived at with which every member of the group can agree.

Notes:

This process is seldom completed in a day. Often it is possible to arrive at two or three versions of whatever is being developed in the first session. It is useful for people to have some time to think about the various versions before trying to reach a consensus on the one and only. Often three or four sessions are necessary to complete the task.

If the group appears to be stalemated – unable to agree on one version or another – the discussion and negotiation process can be speeded up by using a "fish bowl." The opposing groups each select one or two spokespersons for their point of view. The spokespersons form a circle of chairs in the middle of the room, with everyone else seated around them. They continue negotiations while the rest of the group observes; thus a "fish bowl" is formed. An empty chair or two should be provided in the circle for the observers to temporarily join the negotiations whenever they want to make a particular point or put forth a particular argument.

Source: *Building Systems for Professional Growth: An Action Guide* by Margaret A. Arbuckle and Lynn B. Murray. Andover, MA: The Regional Laboratory for Educational Improvement of the Northeast and Islands. ©1989, 4-35.

RULES FOR BUILDING CONSENSUS

Consensus Decision Making:

- Is a process used to ensure that every individual has input into a decision.
- Requires everyone's participation. Listening, sharing, trust, and respect are values inherent in the process.

The Consensus Contract:

Consensus is based on the term "to consent" as in "to grant permission." To arrive at consensus is to give permission to go along with the total group (the majority). The implication of consensus is that an individual can negotiate the terms by which he or she will grant his or her permission. Each individual has the right and obligation to make his or her terms known.

Contract Assumptions	**Commitments/Procedures**
All people are choosing beings.	I will explain my perception of the problem/issue.
All persons are free to disagree and voice an opinion.	I will discuss my feelings.
Freedom means he/she engages in action by choice.	I will explain my needs/goals concerning the issue.
Compromise is not necessary.	I will let others know how important this issue is to me.
There is no right answer.	I will listen to others' opinions.
	I will respect others' needs for space, privacy, and identity.
	I will negotiate.
	I will grant permission to the majority, with a minority report.
	I will implement the decision.

Source: *Building Systems for Professional Growth: An Action Guide* by Margaret A. Arbuckle and Lynn B. Murray. Andover, MA: The Regional Laboratory for Educational Improvement of the Northeast and Islands. ©1989, 4-33 through 4-34.

RULES FOR BUILDING CONSENSUS (continued)

Advantages of a Consensus:

Unlike a majority vote, a consensus requires a full commitment from all the group members to the decision. Because everyone is involved in the decision and must indicate agreement, the outcome is likely to be accepted by most.

(If there is a vote, members in the minority are often not given an opportunity to propose changes, and if they vote NO, they are in effect relieved of any responsibility for the outcome.)

Consensus may take a bit more time in a group, but the outcome is usually more likely to be implemented and supported. It's worth the effort.

Consensus Means . . .	**Consensus Does NOT Mean . . .**
All group members contribute.	A unanimous vote.
Everyone's opinions are heard and encouraged.	The result is everyone's first choice.
Differences are viewed as helpful.	Everyone agrees (there may be only enough support for the decision to be carried out).
Everyone can paraphrase the issue.	Conflict or resistance will be overcome immediately.
Everyone has a chance to express feelings about the issue.	
Those who disagree indicate a willingness to experiment for a certain period of time.	
All members share the final decision.	
All members agree to take responsibility for implementing the final decision.	

B-6 THREE-STEP INTERVIEW

Desired Outcome for Participants:

- To focus on a new topic by linking it to previous experiences and beliefs.

Materials:

- **Transparency:**
  - *Three-Step Interview* (B-6-2)
- Overhead projector, screen, blank paper, and pens or pencils

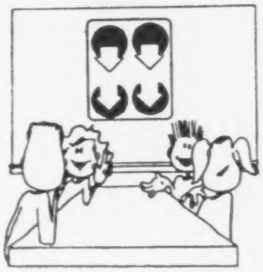
Facilitator's Notes: This technique is good for initial engagement of individuals with a topic. It helps them think about their own experiences and make connections to the topic to be discussed in the exercise. In preparation, the facilitator determines a set of interview questions.

Process:

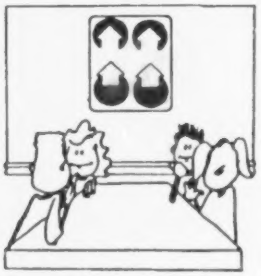
1. Show the **Three-Step Interview (B-6-2)** transparency as you explain each step.
2. Divide participates into groups of four. Ask them to form pairs within the groups of four. Each pair will have an interviewer and an interviewee. The interviewer will ask a set of questions to the interviewee. As the person being interviewed talks, the interviewer takes notes.
3. In the second step, the process is reversed; those who were interviewed now do the interviewing.
4. In the third step, each person reports out in a round-robin fashion what they learned about the person they interviewed.

Source: This activity was adapted with permission of Kagan's Cooperative Learning Company from *Cooperative Learning* by Spencer Kagan. ©1992, 12-2 through 12-4.

THREE-STEP INTERVIEW

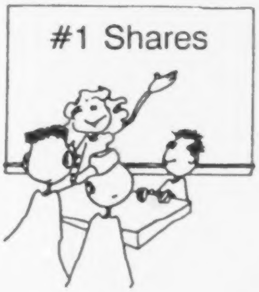


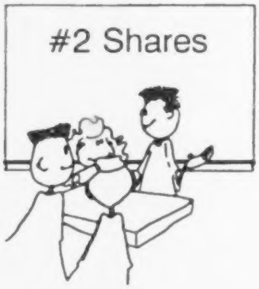
Step 1:
One-Way Interview

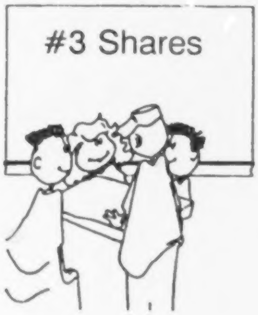


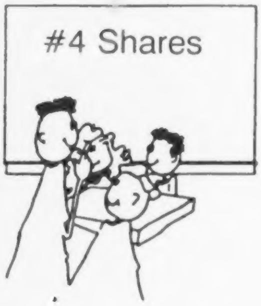
Step 2:
The Reverse

Step 3: Round-robin









Source: Reprinted with permission of Kagan's Cooperative Learning Company from *Cooperative Learning* by Spencer Kagan. ©1992, 12-3.

787

B-7 OTHER SELECTED TECHNIQUES

Desired Outcome for Participants:

- To quickly generate ideas and responses to an issue or a question.

Materials:

- **Transparencies:**
  - *Fast-Write Rules* (B-7-2)
  - *Think-Pair-Share* (B-7-3)
- Overhead projector, screen, blank paper, and pens or pencils

Facilitator's Notes: Both of these techniques provide participants with the opportunity to think about a question or issue and generate a response, either through writing or talking. Both increase active participation and reflection and can be used to break up a period of time spent listening or to provide initial engagement in a new topic.

Process: FAST WRITE

1. This exercise helps participants get thoughts out and down on paper in a short amount of time. Use the **Fast-Write Rules (B-7-2)** transparency to give directions.

THINK-PAIR-SHARE

2. This is another exercise whose purpose is to instantly engage participants in a topic. Use the **Think-Pair-Share (B-7-3)** transparency to explain the process.

FAST-WRITE RULES

- SIT POISED to write with pen-in-hand and a blank sheet of paper.
- READ or LISTEN to a provocative statement, question, or story.
- WRITE without stopping for two minutes. Jot down whatever comes to mind. Your pen should not leave the page.

THINK-PAIR-SHARE

- Participants LISTEN while the presenter poses a question.

- Participants are given time to THINK about a response.

- Participants PAIR with a neighbor to discuss responses.

- Participants SHARE their responses with the large group.

APPENDIX C

Overall Documentation and Evaluation Form C-1

Individual Activity Documentation and Evaluation Form C-2

FACILITATING SYSTEMIC CHANGE IN SCIENCE AND MATHEMATICS EDUCATION: A TOOLKIT FOR PROFESSIONAL DEVELOPERS

▸ Overall Documentation and Evaluation Form ◂

Please complete this form after using one or several *Toolkit* activities. Your feedback will assist us as we continue to network *Toolkit* users. Thank you!

1. Which activities did you use and in what sequence?

2. Why did you use activities from the *Toolkit*?

3. What were the overall goals for the training or events in which you used activities from the *Toolkit*?

4. Do you think the *Toolkit* activities helped you to reach your goals? Why or why not?

5. Did the activities complement or build on each other in any way? If so, how?

6. Did the activities seem related or unrelated? Why? If they seem unrelated, was that a problem?

7. Do you think that the activities need to be used in a particular sequence? Are there are some core activities that should be used with all groups? Which ones?

8. Equity and systemic change are the overarching themes of the *Toolkit*. Were these themes well developed in the activities you used?

   ☐ very well
   ☐ moderately well
   ☐ not well developed

   What ideas do you have to further develop these themes?

9. What issues, concerns, or ideas would you like to share with *Toolkit* developers or other potential users as a result of your experience?

Send completed form to:
Regional Alliance Coordinator
The Regional Laboratory for Educational Improvement
of the Northeast and Islands
300 Brickstone Square, Suite 950
Andover, MA 01810
Telephone: 508-470-0098
FAX: 508-475-9220

FACILITATING SYSTEMIC CHANGE IN SCIENCE AND MATHEMATICS EDUCATION: A TOOLKIT FOR PROFESSIONAL DEVELOPERS

▸ Individual Activity Documentation and Evaluation Form ◂

Please complete a separate form after completing each *Toolkit* activity. Your feedback will assist us as we continue to network *Toolkit* users. Thank you!

ACTIVITY # ____

1. Date of activity: ________________________________

2. Facilitator(s): ________________________________

3. Laboratory or other organization: ________________________________

4. What was the *overall* purpose of the session? ________________________________

   ____

5. Please describe the types of participants, e.g., principals, curriculum directors, etc., and *numbers* of each.

   ____

   ____

6. Was the session part of a larger event (e.g., conference)? If so, what?

   ____

   ____

   ____

774

7. If so, what was the overall theme, goal, or purpose of the larger event? If possible, please attach a copy of the program agenda or general description.

8. What *other Toolkit* activities, if any, were used? # ______________________________

9. Why did you select *this* particular activity from the *Toolkit*?

10. How long did this activity actually take? ______________________________

11. What was most valuable about *this* activity?

12. What was most problematic about *this* activity?

13. How could this activity be improved? Please attach any additional or substitute handouts, transparencies, processes, readings, etc. that you used or would use next time.

14. Was the theme of equity clearly embedded into this activity?

    ☐ Yes

    ☐ No

    Suggestions for improvement:

15. Was the theme of systemic change clearly embedded into this activity?

    ☐ Yes

    ☐ No

    Suggestions for improvement:

16. What follow-up, if any, will there be to this use of the *Toolkit*?

17. What issues, concerns, or ideas would you like to share with *Toolkit* users as a results of this experience?

18. Have you used the activity with other groups?

☐ Yes

☐ No

If yes, which group(s)? ______________________________

____

19. Have you used *other* activities from the *Toolkit*?

☐ Yes

☐ No

20. If yes, which activities have you used? ______________________________

____

Send completed form to:
Regional Alliance Coordinator
The Regional Laboratory for Educational Improvement
of the Northeast and Islands
300 Brickstone Square, Suite 950
Andover, MA 01810
Telephone: 508-470-0098
FAX: 508-475-9220